Appendix 11.1 Peat Slide Risk Assessment

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1 Introduction

1.1 This Peat Slide Risk Assessment (PSRA) report provides an overview of peat slide mechanisms, desk study information relating to the site, and survey results to highlight any risk of peat slide within the Proposed Development area.

1.2 The peat slide risk assessment was led by Jenny Hazzard, Environmental Planning Director at ITPEnergised. Jenny has a BSc in Geological Engineering and an MSc in Engineering Geology, and she is a Practitioner Member of IEMA. Jenny has 20 years of experience in environmental consultancy including EIA, geo-environmental assessment, ground investigations, and assessment of geology, hydrology and hydrogeology impacts. She has led on hydrology, hydrogeology and peat assessment work for several renewable energy and transmission & distribution projects across Scotland, including peat slide risk assessments and peat management plans for several proposed Scottish wind farm projects.

1.3 Field surveys were directed by Jenny and undertaken by members of the ITPEnergised Environmental Planning team and AECOM (project engineering consultants), with suitable experience of peat probing, geo-environmental and hydrological surveys.

2 Peat Failure Characteristics/Mechanisms

2.1 The Peat Landslide Hazard and Risk Assessments Best Practice Guide for Proposed Electricity Generation Developments, published by the then Scottish Executive (2006, updated by the Scottish Government April 2017) (hereafter referred to as the 'Best Practice Guide') determines peat landslide (instability) in two categories, 'peat slides' and 'bog bursts'. It is indicated that peat slides have a greater risk of occurrence in areas where peat depth is shallow (up to 2 m) and slope gradients are steep (5 to 15^{o}). Bog bursts, however, are indicated to have a greater risk of occurrence in areas where peat depth is deep and slope gradients are shallow. As recorded in the Best Practice Guide, bog burst events have generally only been reported in Irish and Northern Irish peat bogs. They are uncommon in Scotland and therefore are not considered to attribute significant risk in relation to this assessment. It is noted that peat instability events (including bog bursts), although extremely uncommon, may occur outside the limits mentioned above.

2.2 Further to the simple definition above, a number of natural factors are considered to interact and create the potential for peat instability to occur. These natural factors would typically include:

- **Slope Gradient:** as noted in the Best Practice Guide, peat slides have a greater likelihood of occurrence where slope angles range from 5 to 15^{o}. Deposits with shallower slope gradients are less susceptible to failure due to the reduced influence of gravity. Deposits with steeper slope gradients are less susceptible to failure due to the general lack of peat presence (although peaty debris slide may occur).
- **Peat Depth:** Boyland et al. (2008) describes three common types of peat, controlled to an extent by rainfall and elevation:
    - Upland Blanket Bog: blanket bogs are typically about 3 m thick, however, they can be up to 5 m thick, generally thinning at higher elevations (note, the Proposed Development site is considered to generally fit the definition of an upland blanket bog site although recorded peat depths are generally shallower than the range noted).
    - Lowland Blanket Bog: similar to the upland version, however, they form around sea levels in areas of very high rainfall.
    - Raised Bog: generally 3-12 m thick, averaging 7 m, with growth occurring above the water table.

2.3 Peat depth can give an indication of peat strength and the potential magnitude of a slide, where the generalisation can be made that the potential for peat instability increases with peat depth provided gradients exist to allow movement. However, when combined with other instability indicators, any depth of peat can fail.

- **Peat Strength:** the shear strength of peat is an important aspect in assessing the risk of landslip in blanket peat areas, with areas of lower shear strength likely to be the cause of any peat slide. However, due to the influence of fibres within the deposits and of stratification with depth, reliable values of shear strength are difficult to near-impossible to obtain, using common place in situ and laboratory soil strength tests. Where data is available, it can be used, with extreme caution, to assist in assessing likely risk.
- **Relief:** the combination of slope gradient and variation in elevation can result in confined and unconfined zones i.e. where undulating or hummocky terrain (confined) exists, the natural relief has the potential to mitigate the occurrence of a peat slide. However, convex sloping hillsides (unconfined) can increase the hazard potential.
- **Evident and/or Potential Areas of Instability:** the presence of certain geomorphological characteristics (refer to paragraph 2.7 below) may signify an increased risk of peat instability. However, peat instability events may occur in areas where no such geomorphological characteristics are present, if the general characteristics match those mentioned above.
- **Vegetation Cover:** the vegetation cover of an area of bog/mire gives an indication as to its hydrological setting and therefore physical characteristics, as noted in the Best Practice Guide and detailed by Hobbs, 1986.
- **Peat Stratification:** the peat formation process causes peat to show natural anisotropic strength. The interface between the three distinct layers (indicating three hydroseral stages) within a peat mass is defined by hydrology. The three layers are:
    - Top Mat: living vegetation of herbaceous plants, grasses and mosses;
    - Acrotelm: decomposing peat which is saturated periodically and is of relatively high permeability; and
    - Catotelm: permanently saturated dense peat of relatively low permeability.

  Peat stratification is linked to peat depth (Dykes, 2006), with thinner peat deposits having a thinner or no catotelm layer. A minimal or absent catotelm layer leads to peat mass having a higher shear strength, as the overlying top mat and acrotelm layers are more fibrous in nature compared to the underlying catotelm layer.
- **Hydrology (Surface and Subsurface):** surface (seeps and springs, wet flushes, watercourses, concentration of drainage networks etc.) and subsurface (pipe systems, underground channels etc.) drainage pathways can provide areas of peat with a water supply which may be absorbed by and potentially increase the mass of the peat. This can cause pooling/piping within the peat mass, or an increase in water at the base of the peat mass, each of which increases the susceptibility of the peat mass to failure.

2.4 The presence of a number of the above natural factors may create the potential for peat instability to occur, however, the actual instability is generally the result of a combination of further contributing factors. These factors have been grouped into two categories within the Best Practice Guide described as preparatory and triggering factors.

2.5 Preparatory factors, which affect the stability of peat slopes in the medium to long-term (tens to hundreds of years), are:

- increase in mass of the peat through peat formation;
- increase in mass of the peat through increase in water content;
- increase in mass of the peat through afforestation;

- reduction in shear strength from changes in the physical structure of the peat due to creep, weathering or vertical tension cracks of the material;
- loss of surface vegetation and associated tensile strength (e.g. deforestation);
- changes in the subsurface hydrology (water filled pools and/or pipes etc.); and
- afforestation reducing the water held in the peat body, increasing the potential for formation of desiccation cracks which can be exploited by rainfall on forest harvesting.

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

- intensive rainfall or snow melt causing development of high porewater pressures within the peat;
- alterations to drainage patterns generating high porewater pressures within the peat;
- peat extraction at the toe of the slope i.e. fluvial incision, cut slopes etc. reducing the support of the upslope material;
- peat loading commonly due to stockpiling or plant during construction (or natural causes i.e. landslide) causing an increase in shear stress;
- changes to the vegetation cover i.e. by stripping the surface cover or afforestation; and
- earthquakes or man-made rapid ground accelerations, such as blasting or mechanical vibrations, causing an increase in shear stress.

2.7 Evidence of the potential for peat instability within an area may be observed through the recording of the geomorphological conditions of the area. These existing geomorphological characteristics may indicate the presence of existing or historical failures or areas of future potential instability. The characteristics of particular interest include the presence of the following:

- historical failure scars and debris;
- tension cracking and tearing;
- compression ridges/thrusts or extrusion;
- peat creep;
- subsurface drainage (pools and/or piping);
- seeps and springs;
- cracking related to drying;
- concentration of surface drainage networks; and
- the presence of organic clays at the peat and bedrock interface.

3 Sources of Data

3.1 A desk study was undertaken to examine documentary information relating to the site. This included the following data sources:

- British Geological Survey, DiGMap and GeoIndex;
- Scottish Natural Heritage (SNH) Carbon and Peatland Map, 2016;
- Hydrogeological Map of Scotland, British Geological Survey, 1988;
- Soil Survey of Scotland Maps, James Hutton Institute;
- Scottish Natural Heritage Natural Spaces online database;
- Habitat and botanical survey data (refer to Chapter 7 and Figures 7.3 and 7.4);

- Historical mapping from the mid-1800s to 1955, available from the National Library of Scotland; and
- Aerial photography (current and 2010).

4 Baseline Conditions

Geography, Topography and Geomorphology

4.1 The main development area of the site comprises mainly conifer plantation forestry. Current use by humans largely comprises forestry management works.

4.2 The topography of the site is characterised by a series of high hilltops from southwest to northeast (Priesthill Height, Nutberry Hill, Standingstone Hill and Tod Law, ranging from 370 m to 522 m Above Ordnance Datum (AOD) at their summits), separated by the valleys of Long Burn, Eaglin Burn and an unnamed minor watercourse, at levels around 300 m to 350 m AOD. To the southeast of this line of hills, the land slopes steeply down to the River Nethan valley, at approximately 275 m AOD at the southeast edge of the site. An additional southern spur, where two proposed turbines are sited, is south of the River Nethan, on land rising up from the river valley to Black Hill (summit elevation 360 m AOD).

4.3 The hills across the site feature largely rectilinear slopes, with some convexity restricted to the hilltops (shallow slopes in the immediate vicinity of the summits, steepening quickly. Other localised areas where slightly convex slopes are observed are on the central part of the eastern slope of Nutberry Hill, the southeast and east slopes of Tod Law, the northeast and east slopes of Standingstone Hill (near the top part of the hill only), and on the lower part of the northern slope of Black Hill. The northwest slope of Tod Law, the lower part of the northeast slope of Nutberry Hill, and the southwest slope of Standingstone Hill are slightly concave.

4.4 **Figure 1** shows the main geomorphological features of the site, including the position of major slope breaks, concave slopes, and major drainage features. Additionally, numerous smaller man-made drainage ditches are present onsite, being too numerous to show on the geomorphology map and are not clearly evident on aerial photography due to the forest cover. However, the presence and concentration of drainage features and wet ground is illustrated by bog, marshy, and occasional flush habitats mapped during habitat surveys, and these habitats are shown on **Figure 1**.

4.5 A selection of photographs below illustrates conditions at the Proposed Development site.

Photograph 1 – Disturbed soils at T6 location **Photograph 2 – T11 location**

Photograph 3 – Burn between T16 and T19 **Photograph 4 – Along track towards T21**

4.6 No clear evidence of any historical slope failure could be discerned from aerial photography (2010 or current editions). Several highly localised areas of fallen trees or areas where growth appears to have failed are evident within the forestry, however none of these areas exhibit the linear/crescent shape across slopes, or downslope run-out, that would be expected for a peat slide.

History

4.7 A review of historical map editions from the mid-1800s to 1955 identified the site as being open moorland with essentially no built development. A coal mine was located at High Monkshead south of the site, and small-scale lead mines were shown to be present on the banks of the River Nethan at the southern edge of the site (disused from the 1800s). Small-scale quarrying was evident in the north of the site on the edge of the Birkenhead Burn in the early 1950s.

4.8 No plantation forestry is shown on historical mapping up to and including 1955. It is not known when the site became forested.

4.9 Current aerial photography was consulted together with aerial photography at 5 m resolution, dated 2010, obtained from Emapsite, as part of the desk study review of site conditions. No material information was gained from this review that was not evident from mapping and site reconnaissance work. The 2010 aerial photography shows the site in largely the same condition as current, with the exception of some forestry blocks which have been felled in the intervening period. Close inspection was undertaken of both sets of aerial photography to identify signs of any failure, creep, changes in topography etc. however no such signs were identified.

4.10 Historical aerial mapping earlier than 2010 was not reviewed given that sufficient information on site conditions, peat depth and distribution etc. was considered to be available from other sources.

4.11 During the design iteration process for the Proposed Development, information has been made available from the Forest Manager, who reported having been involved with forestry management at Cumberhead Forest since 2002 and having no knowledge of any peat slides or landslides either during this period or prior to his involvement with this forest. He also reported having never observed any signs of land/peat slips within the forest during inspections through the mature conifer crop.

4.12 Searches have also been undertaken for any records of evidence of peat slides during construction of nearby wind energy developments located on similar terrain. No such records have been identified.

Vegetation

4.13 Site observations and ecological surveys have identified that most of the site area is occupied by coniferous plantation woodland. The main exceptions are briefly described below, with further detail in Chapter 7:

- The western area between Nutberry Hill and the western site boundary is recently felled coniferous woodland, with localised bog, flush, heath and marshy grassland habitats at the far western edge alongside the site boundary.
- Nutberry Hill itself and the area stretching southwest from the hill to the site boundary is characterised by blanket bog habitat, with localised areas of modified bog, grassland and heath around the boundaries of this blanket bog area.
- The area around the Eaglin Burn valley is characterised by bog, bracken, grassland and heath habitats.
- Grassland and bracken are found along the Birkenhead Burn valley and area immediately to the south.
- An area of blanket bog and modified bog is located in the far north of the site, north of proposed T19.
- Localised areas of wet modified bog, blanket bog, marshy grassland, bracken, and occasional flush habitats are identified along watercourses across the site.

Rainfall

4.14 Rainfall data have been obtained from Eskdalemuir Observatory, approximately 70 km to the south-east of the Proposed Development. A rainfall precipitation rate of 1,634 mm per year is indicated, based on averages collated between 1971 and 2000.

Geological Conditions

4.15 BGS online mapping for the area shows that the bedrock geology underlying most of the site comprises sedimentary rock formations, principally sandstone, mudstone and wacke. Several igneous intrusions are evident, mainly in the southern part of the site.

4.16 BGS mapping shows that bedrock across most of the site area Is overlain by peat. Localised areas in the northeast, east and south are shown as having till overlying bedrock, with no peat. This is expected to comprise poorly sorted sand, gravel, cobbles and boulders in a clay matrix (observed in some exposures to be relatively coarse gravels, sands and cobbles). The routes of watercourses onsite have either little or no superficial material over bedrock, or alluvial deposits comprising clays, silts, sands and gravels.

4.17 The SNH carbon and peatland mapping (2016) defines most of the site as Class 5 peat, where no peatland habitat is recorded, but where soils are carbon-rich and deep peat. Swathes of land in the southeast, northwest and north are defined as Class 4, or areas unlikely to be associated with peatland habitats and unlikely to include carbon-rich soils. Localised areas in the southwest and east are Class 0, mineral soils. The area at Nutberry Hill in the southwest, extending southwest to the site boundary, is defined as Class 1 peat, defined as “nationally important carbon-rich soils, deep peat and priority peatland habitat; areas likely to be of high conservation value”.

4.18 Peat depth surveys were undertaken as described in Section 5, to identify and characterise peat deposits that may be present around proposed turbines and associated infrastructure. The peat depth surveys identified areas of deep peat concentrated around the central, low-lying valley between Nutberry Hill and Standingstone Hill, the far north of the site, and the far southwest. The remaining areas surveyed were found to have peat depths generally less than 50 cm, therefore defined as peaty soil (refer to paragraph 5.13).

4.19 Peat across most of the site was observed to be disturbed and modified by the presence of tree roots and, in some areas uprooted due to wind blow. Conifer needles blanketed much of the site area within the forestry, obscuring ground conditions. However, in some locations, exposed banks of watercourses exhibit granular till materials (see below). Near the proposed T3 location, an exposure adjacent to a watercourse exhibits peat overlying weathered sedimentary rock.

Photograph 5 – Exposed peat over rock near T3

Surface Water

4.20 There are a number of watercourses within the site boundary and immediate surrounding area, with the two largest being the River Nethan in the south and the Logan Water in the north.

4.21 The River Nethan rises within the forest at the western edge of the site and flows from southwest to northeast. It forms the southern boundary of the main body of the site. The Eaglin Burn, Pockmuir Burn, and numerous additional tributaries flow into the River Nethan from the southern and eastern parts of the site.

4.22 The Logan Water rises on the eastern slope of Spirebush Hill to the west of the site, flowing north/northeast and following approximately the western site boundary to the Logan Reservoir, then turning east and south to join the River Nethan some 3 km northeast of the site boundary. The Birkenhead Burn, Long Burn and several additional tributaries flow into the River Nethan from the northern and western parts of the site.

4.23 All site drainage is eventually to the River Nethan via the above routes. Beyond the immediate site area, the River Nethan continues to flow generally east and north, under the M74 near Lesmahagow and into the River Clyde near Crossford.

4.24 The River Nethan water was classified by SEPA in 2018 as Moderate quality, and the Logan Water was classified by SEPA as Good in 2018.

4.25 Most of the watercourses on site feature narrow, well-defined channels within fairly wide, boggy or grassy banks between areas of forestry. At some watercourses towards the southwest, exposed banks exhibit granular, gravelly/cobbly till. Further descriptions of the watercourses and photographs are provided in Appendix 11.3, the schedule of proposed water crossings.

Hydrogeology

4.26 The groundwater body beneath the site is indicated by SEPA to comprise the North Glengavel groundwater. This groundwater body was classified by SEPA in 2018 as having an overall status of good.

4.27 The Hydrogeology Map of Scotland identifies the site as being underlain by a low productive aquifer in which flow is virtually all through fractures and other discontinuities.

4.28 Peat and peaty soils would also be expected to inhibit groundwater flow. Till, where present, is also anticipated to be relatively low, although variable permeability, inhibiting groundwater flow. The alluvial deposits on the banks of watercourses may exhibit higher permeability.

4.29 No Private Water Supplies (PWS) have been identified within a 1 km radius of the site boundary.

Human Receptors

4.30 Human receptors that may be at risk from peat slide include: construction staff during construction of the development, and the forestry workers accessing the site. Given the transient use of the site by these receptors, there is considered to be a low risk of direct harm from peat slide. However, the potential consequence of peat slide affecting onsite roads and therefore indirectly affecting forestry works and access, is considered further within the assessment.

Ecology

4.31 No terrestrial protected species have been identified as likely to be impacted by peat slide within the study area. Therefore, these have not been considered further in this assessment. The Muirkirk Uplands Site of Special Scientific Interest (SSSI) adjacent to the site boundary is nationally designated for its blanket bog and upland habitats and is therefore a highly sensitive receptor. It is therefore considered in the assessment of peat slide risk.

4.32 Ecological resources associated with watercourses are considered as part of the identified surface water receptors noted in the Surface Water section above.

Archaeology

4.33 A number of heritage assets have been identified within the site boundary, however none were assessed as being of any greater than low sensitivity. These are not considered highly sensitive to potential impact by localised peat slide, and are not considered further in the assessment.

Infrastructure and Built Environment

4.34 There are existing forestry tracks across the site, many which are proposed to be incorporated into the Proposed Development, which could potentially be impacted by peat slide and are considered in the assessment. The proposed turbines themselves also have the potential to be impacted by peat slide derived from other infrastructure locations which may be upslope. The turbines are considered as potential receptors, in the assessment of peat slide risk.

4.35 The nearest residential property is 780 m from the nearest turbine, with other individual properties from approximately 1 km or more outside the site boundary. Residential receptors which are downslope of the Proposed Development have been considered in the assessment of peat slide risk.

5 Peat Depth Survey

5.1 Based on a desk study review of published geological mapping, it was anticipated that peat could be present across much of the Proposed Development site, with some localised areas interpreted as likely having no peat deposits (mainly on hilltops/steep slopes and along watercourse banks).

5.2 A peat depth survey was therefore undertaken in three phases. Initially, a 'Phase 1' peat survey programme was undertaken, focusing on the vicinity of proposed turbine and new infrastructure locations, which had been devised as part of a design iteration process taking account of a range of physical and environmental constraints, including desk study findings relating to peat. It was considered appropriate to diverge from the relevant guidance on peat surveys (Guidance on Developments on Peatland - Site Surveys (2017), which recommends a 100 m grid of peat probe locations as an initial high-level survey strategy across an entire development site), due to the likelihood of substantial historical peat disturbance at the site, the considerable physical restrictions on accessing areas of dense forestry, the re-use of substantial existing forest road infrastructure, and the other established technical and environmental constraints guiding the layout iteration process.

5.3 This initial Phase 1 survey demonstrated that, in the main, proposed turbine and infrastructure locations were practical and made the most of existing forest roads. However, some localised deep peat was identified, prompting design changes to move infrastructure to areas of interpreted shallower peat. It was also concluded that there were gaps in the data obtained from the Phase 1 survey, requiring additional survey effort to further inform the design iteration process, prior to completing detailed Phase 2 survey work at confirmed 'design chill' infrastructure locations.

5.4 Therefore, a 'Phase 1b' survey programme was undertaken, seeking to gain peat depth data at and in the vicinity of proposed infrastructure locations where no data was available from Phase 1, as well as extending the coverage of survey points around proposed infrastructure locations, to aid in micro-siting or indeed more substantial re-siting of infrastructure where deeper peat was identified.

5.5 Following completion of Phase 1b surveys, the site design was further reviewed, and changes were made to avoid or minimise siting infrastructure on areas of deeper peat. A 'design chill' was arrived at, and Phase 2 surveys were subsequently undertaken, comprising detailed surveys at each proposed turbine and hardstanding location, along all proposed new access tracks, and at other proposed infrastructure locations including the site substation, met masts, construction compounds, laydown area, and borrow pit search areas.

5.6 The pattern of peat probing in relation to proposed turbine locations and other infrastructure elements can be broadly described as follows:

- Probe at each proposed turbine location and plus a minimum of 50 m from the turbine location to the north, south, east and west. Additional points around proposed turbine locations were taken where initial results indicated peat (>0.5 m depth) may be present;
- Approximately five probes at each proposed turbine hardstanding area (centre and four outside corners);
- Every 50 m along proposed new access tracks, plus approximately 10 m either side of each probe, perpendicular to the route of the track;
- A minimum of five probes at the location of the proposed substation, temporary compound, temporary laydown area and within the proposed borrow pit search areas; and
- Several probes at or in the vicinity of the two proposed met mast locations.

5.7 Consultation was maintained with SEPA throughout the peat survey programme, to set out the proposed survey strategy, provide preliminary findings, and seek feedback. Although the above survey approach does diverge from the relevant guidance for the reasons set out above, it was agreed with SEPA that the surveys were appropriate and suitable for informing site design and assessment work.

5.8 Data obtained from the peat depth surveys were used to plot the presence and distribution of peat across the proposed infrastructure development areas at the site, create a contour plan, and feed into detailed design iteration.

5.9 In total, data has been obtained from 1,362 peat probe locations across the site area. **Figure 2** shows the peat survey locations, and Annex 1 provides the full set of peat survey data (probe locations and recorded depths).

5.10 Peat sampling was undertaken using a hand auger, at proposed turbine and infrastructure locations. Samples retrieved from hand augering were examined to provide additional information and understanding of the nature of peat at varying depths and locations. Selected peat samples, from locations where peat depth greater than 0.5 m was recorded, were dispatched to Envirolab laboratory and tested for moisture content, bulk density, and carbon content. Table 1 provides information on the location and depth of peat samples tested, and a selection of photographs is provided below Table 1 to show the nature of peat and peaty soils extracted by hand auger at these locations. The laboratory testing report is provided as **Annex 3**

Table 1 – Locations of Peat Samples Collected for Laboratory Analysis

Location	Easting	Northing	Depth (m below ground)	Notes
Turbine 1	273972	632452	0.99	Dark brown, wet, somewhat fibrous in upper part only, possible acrotelm/catotelm boundary. Fairly high carbon and moisture content.
Turbine 2	273971	633022	0.65	Pale brown, very low carbon and low moisture content, not peat.
Turbine 4	274485	632982	0.55	Medium brown, cohesive. Very low carbon and moisture content, not peat
Turbine 5	275207	633452	0.90	Pale brown, very low carbon and low moisture content, not peat.

Location	Easting	Northing	Depth (m below ground)	Notes
Turbine 7	273914	634053	1.00	Dark brown, not fibrous. Fairly high carbon and moisture content.
Turbine 9	274592	634184	0.85	Dark brown, somewhat fibrous. Fairly high carbon and moisture content.
Turbine 10	274504	634697	0.78	Medium brown, fibrous in upper part. Fairly high carbon and moisture content.
Turbine 13	275843	634840	0.50	Medium/dark brown, fibrous. Low carbon and low moisture content, peaty soil but not peat.
Turbine 15	275885	635450	0.80	Medium brown, fairly cohesive. Moderate carbon and moisture content, likely peaty soil but not peat.
Turbine 16	275615	635837	0.65	Medium brown, granular. Very low carbon and moisture content, not peat.
Turbine 17	276395	635346	0.55	Medium/dark brown, somewhat cohesive. Moderate carbon and moisture content, likely peaty soil but not peat.
Turbine 19	276280	636033	0.60	Medium/dark brown, not fibrous. Fairly high carbon and moisture content.

5.11 As set out in Table 1, laboratory testing results from samples of peat taken during peat depth surveys identified moisture contents generally within or slightly below the typical values for peat of 85 to 95% for half of the 12 samples, while moisture contents were well below this range in the other half. Carbon contents were recorded as being substantially below the typical value of 55% for peat in the same six samples which exhibited low moisture contents (taken from the proposed locations of T2, T4, T5, T13, T15 and T16). This suggests that materials in at least some areas of the site may be considered peaty or organo-mineral soils, rather than peat.

Photograph 6– Auger from T2 **Photograph 7 – Auger from T5**

Photograph 8 – Auger from T7 **Photograph 9 – Auger from T9**

Photograph 10 – Auger from T13

Photograph 11 – Auger from T19

Survey Results

5.12 The general distribution of depth of penetration recorded during the peat survey is summarised in Table 2 and presented in **Figure 3**.

Table 2 – Distribution of Peat Depth Recorded at the Site

Peat Depth Interval (m)	Number of Occurrences	% of Probes
Nil	7	0.5
0.01 to 0.5	435	31.9
0.51 to 1.00	555	40.7
1.01 to 1.50	199	14.6
1.51 to 2.00	92	6.8
2.01 to 2.50	45	3.3
2.51 to 3.00	24	1.8
3.0 or more	5	0.4
Total	**1,362**	**100**

5.13 The Peat Landslide Hazard Best Practice Guidance (2017) uses the following Joint Nature Conservation Committee (JNCC) report 445 'Towards an Assessment of the State of the UK Peatlands' definition for classification of peat deposits:

- Peaty (or organo-mineral) soil: a soil with a surface organic layer less than 0.5 m deep;
- Peat: a soil with a surface organic layer greater than 0.5 m deep which has an organic matter content of more than 60 %;

- Deep Peat: a peat soil with a surface organic layer greater than 1.0 m deep.

5.14 Applying these definitions indicates that the deposits underlying around 32% of the surveyed site area comprise peaty or organo-mineral soil. The above definition of peat applies to conditions recorded at around 41% of probes, with the remaining 27% of probes encountering deep peat.

Peat Contour Mapping

5.15 **Figure 3** (a to d) shows the interpreted peat depth, both as individual data points and as a contour plan based on interpolation of those peat sampling data points. The contouring has been undertaken using Natural Neighbour interpolation function within the Spatial Analyst Tools of ArcMap 10, which finds the closest subset of input samples to a query point and applies weights to them based on proportionate areas in order to interpolate a value.

5.16 Apart from peat depth at each survey point, no other inputs were defined by the user. Information from ESRI (the software provider) defines the Natural Neighbour function as such: "Interpolates a raster surface from points using a natural neighbour technique". As shown on **Figure 3**, interpolation has not been undertaken between probed areas, where no data is available. No assumptions have been made as to peat depth distribution outside the surveyed areas.

5.17 The peat contour mapping shows areas of peat with depth over 1 m, largely in the low-lying central area between Nutberry Hill and Standingstone Hill, the low-lying area west of Tod Law, and the far north of the site, north of the Birkenhead Burn.

5.18 The far southwest area of the site also exhibited peat depths greater than 1 m, however shallower than the above-noted areas, with no probes in the southwest recording peat deeper than 2 m.

6 Peat Stability Hazard Scoring

Introduction

6.1 The Best Practice Guide defines the hazard scoring assessment as 'the likelihood of a peat landslide event occurring'. It states that there are a number of possible methods for hazard scoring and that an initial qualitative hazard scoring matrix methodology be employed using professional judgement based on qualitative scoring scales.

Methodology

6.2 The allocation of hazard score values for the various parameters which influence peat landslide occurrence (e.g. slope gradient, peat depth) is not defined in the Best Practice Guide and there is no published guide specifically relating to this issue. As such, it is left to the assessment teams to develop their own approach for categorising the hazard scoring for the site and the following sections outline the approach used for this specific site.

6.3 Firstly, it is important to note that the Proposed Development layout, including siting of turbines and other infrastructure, resulted from an iterative process which took into account the findings from peat survey work. Deeper peat was avoided wherever possible, in order to minimise the requirement to disturb and/or excavate peat, and to minimise peat slide risk associated with construction across and within peat.

6.4 Given that there is no evidence of current or historical peat instability at the site, and that the site design largely avoids areas of deep peat and steep slopes, it is considered appropriate to focus the assessment of peat slide risk on the proposed infrastructure locations, rather than the wider site where no disturbance or construction activity is proposed.

6.5 The potential for a peat slide to occur is controlled by a number of natural controlling factors. These are typically:

- Slope gradient;
- Peat depth;

- Peat strength;
- Relief;
- Evidence of historical failures/potential instability (e.g. tension cracks, creep, compression ridges);
- Vegetation cover; and
- Hydrology.

6.6 The Best Practice Guide relates peat landslide hazard, or likelihood, to a scale of 1 to 5, with 1 being negligible likelihood and 5 being almost certain. This scale relates to the final hazard potential for all the controlling factors under consideration. No guidance is provided on how the various factors should be combined to derive a final hazard scoring and the assessment team has derived a numerical scoring system as detailed in the following sections.

6.7 The most important of the above controlling factors are considered by the assessor to be peat depth and slope gradient as without both of these elements a risk of peat slide would be unlikely to exist. However, there are additional factors which can contribute to the potential for instability to occur, as set out above, and these have been considered in the evaluation of likelihood of peat slide (i.e. hazard scoring). This approach to the hazard, or likelihood, evaluation is described below and has resulted from a review of several case studies and assessments by experts in PSHRA for Scottish wind energy developments, and associated literature sources on peat slide mechanisms and reported contributing factors, as referenced in the sections below.

6.8 In total, eight factors have been considered in the hazard scoring process. These are noted below, with details of the scoring attributed for each factor set out in the subsequent paragraphs.

- Slope angle
- Peat depth
- Nature of substrate
- Geomorphology
- Drainage/hydrology
- Forestry
- Relief/convexity
- Land use

6.9 Peat strength has not been included as a factor in the hazard scoring process. Site specific peat strength data was not collated for the site given the difficulty in obtaining reliable values of shear strength using common place in situ and laboratory soil strength tests. The shear strength is also linked to peat depth as strength is considered to decrease with thickness. As such this parameter is considered to be factored into the hazard scoring for peat depth.

6.10 It is important to note that this study only focuses on peat soils and the criteria used are specifically tailored to the key factors affecting peat stability. As such it does not account for the stability of other mineral soils or rock.

Input Data Sets

6.11 The input data sets used for the analysis were as follows:

- Slope angle: Terrain 5 DTM with a 5 m grid size;
- Peat depth: Site survey information for peat depth and site observations;
- Substrate: Surveyor observations of substrate "feel" at the refusal point during probing, together with BGS geological mapping and surveyor observations of exposed substrate at the site;
- Geomorphology: Surveyor observations and aerial photography;

- Drainage: Surveyor observations, mapping and aerial photography;
- Forestry: Surveyor observations, mapping and aerial photography;
- Relief (convexity): Topographical mapping; and
- Land use: Surveyor observations, mapping and aerial photography.

6.12 The assessment focuses on the proposed infrastructure locations (turbines including hardstandings, tracks, substation compound, temporary construction compounds, laydown area, borrow pit search areas, and met masts).

Hazard Scoring and Ranking

6.13 There is no guidance available on how to combine the hazard scoring for each of the factors used in the assessment. The assessment team have used the methodology set out below, based on a review of case studies and assessments undertaken by a range of experts (in particular, a hazard scoring methodology adopted by east point geo on a number of assessments, including recently for the proposed Energy Isles Wind Farm in Shetland (east point geo, 2019)), informed by various literature sources as referenced below.

6.14 For each of the eight factors noted above, a score of zero to three has been assigned. A zero score reflects no contribution to peat slide likelihood, with a score of three indicating a high peat slide likelihood associated with that particular factor.

6.15 The total hazard score is the sum of the eight individual factor scores, with the maximum total hazard score therefore being 24.

Slope Angle

6.16 The limiting factor governing the formation of thick peat deposits is topography. In the case of blanket peat, it tends to be deepest in closed depressions, and typically thin as the slope angle increases (Boylan et al. 2008). The Best Practice Guide details that peat slide hazard risk assessment is not needed for blanket bog sites with slopes less than 2° and as such, a score of zero has been assigned for slopes less than 2^{o}. For slopes greater than 2 , scores have been assigned based on the type and nature of peat slides reported for different slope conditions.

6.17 A slope angle GIS layer was generated from the DTM at a 5 m cell resolution. The source DTM is also at a 5 m resolution. The slope angle details are illustrated in **Figure 4**.

6.18 This slope, calculated in degrees, was identified at each proposed infrastructure element and scored as shown in Table 3.

Table 3 – Peat Stability Hazard Scoring (Slope)

Slope (degrees)	Slope Score	Notes
<=2.0	0	Failure unlikely due to flat ground
2.1 – 5.0	2	Failure in blanket bog areas would typically occur as peat slides and peaty debris slides, due to low slope angle.
5.1 – 15.0	3	Failure in blanket bog areas would typically occur as peat slides, bog slides or peaty-debris slides. This is the key slope range for reported peat failures
15.1 – 20.0	2	Failure would typically occur as peaty-debris slides due to low thickness of peat on steeper slopes.

Slope (degrees)	Slope Score	Notes
>20.0	1	Failure would typically occur as peaty-debris slides due to low thickness of peat on steeper slopes.

Peat Depth

6.19 Peat thickness is seen as one of the key factors associated with peat stability. Typically, the deeper the peat the more humified, and therefore potentially weaker and unstable it is. Peat depth surveys have been completed on the site and these data were then interpolated using the Natural Neighbour interpolation function within the Spatial Analyst Tools of ArcMap 10.3 (see **Figure 3**).

6.20 The highest hazard scores have been assigned to peat depth ranges most frequently associated with peat slides on upland sites (Evans and Warburton, 2007).

6.21 The peat depth was identified at each proposed infrastructure element and scored as shown in Table 4.

Table 4 – Peat Stability Hazard Scoring (Peat Depth)

Peat Depth (m)	Depth Score	Notes
Nil	0	No peat/organic soil therefore no potential for peat slide
<=0.5	1	Peaty/organic soil rather than peat, therefore failures would be peaty-debris slides
0.51 – 1.5	3	Sufficient peat thickness for peaty debris or peat slide
>1.5	2	Sufficient peat thickness for peat slide however less often recorded at this thickness, due to thicker peat generally occurring in areas of shallow gradients

Substrate

6.22 The nature of the substrate beneath peat deposits can have a bearing on the likelihood of instability arising, with failure often occurring at the interface between the base of the peat mass and the top of the substrate. A smooth, relatively impermeable substrate surface can result in a 'slippery' interface, accumulation of groundwater and/or low shear strength at the interface, resulting in a higher susceptibility for the overlying peat mass to fail. Conversely, granular substrate such as sand and gravel or permeable bedrock, can provide greater frictional strength, reducing the potential for failure to occur at the peat/substrate interface.

6.23 The nature of the substrate was inferred at each proposed infrastructure element, based on surveyor observations and BGS geological mapping, and scored as shown in Table 5. It should be noted that observations of exposed bedrock and substrate (poorly sorted, generally granular till and weathered sedimentary bedrock) could be made at various locations across the site, increasing confidence in identification of the substrate across the site as bedrock (assigned a score of 1 for conservatism and given the likely low permeability) or granular till.

Table 5 – Peat Stability Hazard Scoring (Substrate)

Substrate	Substrate Score	Notes
Permeable bedrock	0	Peat failure rarely associated with permeable bedrock
Impermeable bedrock/ granular till	1	Peat failures sometimes associated with bedrock or granular till substrate
Cohesive (clay) till	2	Peat failures often associated with cohesive till substrate
Cohesive (clay) till with iron pan	3	Peat failures often associated with cohesive till substrate, with impermeable iron pan providing a shear surface (Dykes and Warburton, 2007)

Geomorphology

6.24 Geomorphological considerations such as peat erosion, hagging, peat pipes, pools, and evidence of existing instability, can contribute to the potential for instability to arise.

6.25 The geomorphological conditions were noted at each proposed infrastructure element, based on surveyor observations, mapping and aerial photography, and scored as shown in Table 6.

Table 6 – Peat Stability Hazard Scoring (Geomorphology)

Geomorphology Description	Geomorphology Score	Notes
Gullied/dissected/hagged/eroded peat/bare peat/bare ground	1	Failures rarely recorded in peat fragmented by erosion
Existing peat slide	1	Failures typically stabilise after the event
Evidence of peat pipes/collapsed pipes, flushes, pools	2	Failures frequently associated with soil piping and areas of diffuse surface drainage such as flushes and pools
Intact planar peat	2	Failures frequently recorded in intact, planar peat
Emerging instability (tension cracks, compression ridges, bulging, quaking bog)	3	Failures likely to occur where evidence of emerging/ developing instability is observed
Adjacent/upslope (<50m) to existing instability	3	Failures frequently occur in close proximity to previous failure events

Drainage

6.26 The presence and geometry of natural and artificial drainage features can affect the stability of a peat mass, by creating lines of weakness. Where drainage features follow the slope direction, this effect is not likely to be as pronounced as drainage features being either oblique to or perpendicular to the slope direction.

6.27 The drainage conditions were noted at and in the vicinity (within ~100 m) of each proposed infrastructure element, based on surveyor observations, mapping and aerial photography (supplemented by habitat survey findings given the difficulty in identifying drainage details in dense forestry from aerial photography), and scored as shown in Table 7.

Table 7 – Peat Stability Hazard Scoring (Drainage)

Drainage Feature	Drainage Score	Notes
No artificial or natural drainage features	0	No impact on peat slide likelihood
Artificial drains or natural watercourses/drainage features aligned to slope direction	1	Peat slides are rarely associated with drainage features aligned to the slope direction
Artificial drains or natural watercourses/drainage features oblique to or across slope	3	Peat slides have been reported in areas with drainage features oblique to or perpendicular to the slope direction

Forestry

6.28 The presence of forestry can increase the mass loading and affect the potential for instability. The alignment of forestry rows, and the presence or otherwise of desiccation cracking are factors which can influence stability (Bragg & Lindsay, 2005).

6.29 Hazard scores relating to forestry are set out in Table 8.

Table 8 – Peat Stability Hazard Scoring (Forestry)

Forestry Description	Forestry Score	Notes
Not afforested	0	No impact on likelihood of peat slide
Deforested, ridge and furrows aligned to slope	2	Likely high water table, lines of weakness may be present but aligned to slope direction
Deforested, ridge and furrows oblique to slope	3	Likely high water table, lines of weakness may be present (cracks), oblique to or across slope and therefore more likely to result in instability
Mature forest, ridge and furrows aligned to slope	1	Forestry affects loading/mass but rows aligned to slope direction are less likely to result in instability than rows oblique to or across slope
Mature forest, ridge and furrows oblique to slope	2	Forestry affects loading/mass and rows oblique to or across slope direction are more likely to result in instability

Relief (Convexity)

6.30 Several references have been made to peat instability initiating at convex and concave slopes. In particular, convex slopes may have thicker peat upslope, with the potential to buckle and fail, with thinner peat further down the slope providing limited support (Dykes & Warburton, 2007; Boylan & Long, 2011).

6.31 The relief, specifically the identification of slopes being planar, convex or concave, was noted at each proposed infrastructure element, based on topographical mapping, and scored as shown in Table 9.

Table 9 – Peat Stability Hazard Scoring (Relief)

Relief/Profile	Relief Score	Notes
Planar slope	0	No impact on likelihood of peat slide
Concave slope	2	Peat slides occasionally reported associated with concave slopes
Convex slope	3	Peat slides often reported associated with convex slopes

Land Use

6.32 Land uses such as moor burning, quarrying, and peat cutting, can impact on the stability of the peat mass.

6.33 The nature of the land use was noted at each proposed infrastructure element, based on surveyor observations, mapping and aerial photography, and scored as shown in Table 10.

Table 10 – Peat Stability Hazard Scoring (Land Use)

Land Use Feature	Land Use Score	Notes
Evidence of burning	1	Burning activities may theoretically create desiccation cracking and allow water to flow to the base of the peat, creating a failure surface (limited evidence in practice)
Quarrying adjacent to location	2	Failures have been reported adjacent to quarrying activity, although typically bog bursts or flows rather than peat slides in blanket bog areas
Peat cutting	3	Peat failures have often been reported associated with peat cutting
Any land use other than noted above	0	No impact on likelihood of peat slide

Peat Slide Hazard Scoring Summary

6.34 As noted in paragraph 6.15, the scores assigned for each of the above eight factors were summed to give a total hazard score associated with each proposed infrastructure element.

6.35 Hazard (likelihood) category rankings have then been assigned based on the total hazard scores. The hazard rankings reflect the qualitative likelihood of failure, from very low to very high, taking into account the combination of all factors described above. The maximum hazard score, if all element scores are three, is 24. Where the hazard score is less than 12, i.e. less than half the maximum, the likelihood of failure is considered to be very low or low.

6.36 Table 11 sets out the hazard category ranking system employed in this assessment.

Table 11 – Hazard Ranking

Total Hazard Score	**Hazard Ranking**	**Hazard (Likelihood) Description**	**Notes**
<=6	1	Very Low	Low scores for peat depth, slope angle, and other factors
7 to 11	2	Low	Generally low scores for peat depth and slope angle, potentially some moderate or occasional high scores for certain factors
12 to 16	3	Moderate	Moderate to high scores for peat depth and slope angle, some elevated scores for other factors
17 o 21	4	High	High scores for peat depth, slope angle, and several other factors
>21	5	Very High	High scores for most or all factors

6.37 Detailed hazard scoring, showing the scores given to each infrastructure element for each of the above factors, is set out in **Annex 2**. Table 12 below presents a summary of the Hazard Ranking for each proposed infrastructure element at the site, using the methodology described above.

6.38 The access track sections noted below are labelled on **Figures 3 and 4**.

Table 12 – Hazard Scoring Summary

Infrastructure Element	Total Hazard Score	Hazard Ranking	Hazard (Likelihood) Description
Turbines (including hardstandings)			
T1	12	3	Moderate
T2	12	3	Moderate
T3	11	2	Low
T4	10	2	Low
T5	13	3	Moderate
T6	12	3	Moderate
T7	11	2	Low
T8	15	3	Moderate
T9	10	2	Low
T10	12	3	Moderate
T11	11	2	Low
T12	11	2	Low
T13	6	1	Very Low
T14	13	3	Moderate
T15	11	2	Low
T16	9	2	Low
T17	11	2	Low
T18	13	3	Moderate
T19	8	2	Low
T20	12	3	Moderate
T21	9	2	Low

Infrastructure Element	Total Hazard Score	Hazard Ranking	Hazard (Likelihood) Description
Other Infrastructure			
Meat Mast 1	8	2	Low
Met Mast 2	11	2	Low
Substation Compound	13	3	Moderate
Temporary Compound (S)	10	2	Low
Temporary Compound (N)	14	3	Moderate
Laydown Area	10	2	Low
Borrow Pit Search Area (S)	12	3	Moderate
Borrow Pit Search Area (W)	13	3	Moderate
Borrow Pit Search Area (N)	11	2	Low
New Access Track Sections			
Track - A	12	3	Moderate
Track - B	12	3	Moderate
Track - C	9	2	Low
Track - D	10	2	Low
Track - E	10	2	Low
Track - F	10	2	Low
Track - G	12	3	Moderate
Track - H	15	3	Moderate
Track - I	16	3	Moderate
Track - J	10	2	Low
Track - K	12	3	Moderate
Track - L	12	3	Moderate
Track - M	13	3	Moderate

Infrastructure Element	Total Hazard Score	Hazard Ranking	Hazard (Likelihood) Description
Track - N	9	2	Low
Track - O	8	2	Low
Track - P	10	2	Low
Track - Q	9	2	Low
Track - R	11	2	Low
Track - S	12	3	Moderate
Track - T	12	3	Moderate

6.39 As can be seen from Table 12, the slight majority of the infrastructure elements have been assigned hazard rankings of low (26 of the 50 elements assessed), with one additional element assigned a ranking of very low. The remaining 23 elements have been assigned a hazard ranking of moderate. The moderate hazard rankings reflect that various locations across the site feature moderate slopes with peat depths recorded over 0.5 m, with some other factors such as drainage and (in most areas) forestry contributing to the potential for instability to arise.

6.40 For a site with no evidence of historical failures, and no records of failures during construction or operation of nearby windfarms on similar terrain, the results of the above hazard scoring process suggest that the analysis may be somewhat conservative. However, the potential for instability to arise, particularly in the event of loading/disturbance, has been identified and requires further consideration with respect to the potential consequences of failure, and therefore overall risk.

7 Peat Slide Hazard Risk Assessment

Methodology

7.1 The level of risk allocated to a particular area relates to the presence of peat, the likelihood of failure occurring (the hazard) and the consequences of such a failure (the exposure). Risk assessment should be based on consideration of the hazard (discussed above) and exposure (consequence of peat failure):

Hazard x Exposure = Risk

Consequences of Peat Failure (Exposure)

7.2 The effects of peat failures are felt locally, both in the long and short term, but they can also have wider off-site implications.

7.3 A key part of the risk assessment process is to identify the potential scale of peat failure, should it occur, and identify the potential environmental effects as well as the receptors of such an event.

7.4 Predicting the size of a failure and the distance it may travel is very difficult. The high moisture content of peat makes it especially mobile once it fails and the structure of the peat breaks down. If a peat slide enters a watercourse this can mobilise the slide further and have impacts many kilometres beyond the bounds of the site. In many instances, minor slumps are localised and have little or no impact. Other failures may travel 100 – 200 m and those entering watercourses, many miles, as was the case of the Derrybrien failure in Co. Galway, Ireland in 2003 (Bragg & Lindsay 2005).

7.5 Peat failure associated with the Proposed Development could affect the following key receptors:

- The Proposed Development itself including associated infrastructure;
- Site workers and plant (risk of injury/death or damage to plant);
- Public roads and other infrastructure;
- Dwellings, business properties and communities;
- Land based ecological effects (damage to habitats);
- Effects on the quality of onsite and downstream watercourses;
- Site drainage (blocked drains/ditches leading to localised flooding and/or erosion);
- Archaeological assets; and
- Visual amenity (scarring of the landscape).

7.6 The surface watercourses on and adjacent to the site and other potentially sensitive receptors are described in paragraphs 4.17 to 4.32 above. The sensitive features considered in the assessment are: surface watercourses; the Muirkirk Uplands SSSI adjacent to the site; the Proposed Development infrastructure (principally turbines); residential properties downslope from the Proposed Development; and existing forestry roads on the site.

7.7 The following approach to analysis of the consequence, or exposure, has been based on a review of PSHRA reports undertaken by a range of professionals for different sites across Scotland, together with reference to the guidance and literature noted above, and professional experience. The analysis considers the sensitivity of the receptor, the distance between the potential source of instability and the receptor, and the relative elevation of the source compared to the receptor. This is considered to be a more realistic and suitable analysis than considering distance alone, given that a receptor which is close to a source area but is up-gradient from it, would not be affected by run-out from the resultant failure.

7.8 In this assessment, the proposed infrastructure elements are considered to be the potential sources areas of instability. The exposure assessment involves identification of sensitive receptors in the down-gradient direction from each proposed infrastructure element (source area), and assigning scores for sensitivity of receptor, proximity, and relative elevation. The rationale for assigning each of these scores is set out in Tables 13 to 15 below.

Table 13 – Exposure Scoring (Receptor Sensitivity)

Receptor Type	Sensitivity Score
Minor private roads/tracks, including Proposed Development tracks	1
Local drainage systems/artificial drains, rural land	2
Watercourses, local roads and services, individual dwellings and business properties	3
High-sensitivity watercourses (e.g. national or international designations), major infrastructure (major roads, motorways, pipelines), proposed turbines, small settlements (up to ~ 10 residents)	4
Communities (more than approximately 10 residents)	5

Table 14 – Exposure Scoring (Proximity)

Proximity of Receptor to Source	Proximity Score
More than 1 km	1
100 m to 1 km	2
50 m to 100 m	3
10 m to 50 m	4
Less than 10 m	5

Table 15: Exposure Scoring (Relative Elevation)

Relative Elevation of Source above Receptor	Sensitivity Score
Less than 10 m	1
10 m to 50 m	2
50 m to 100 m	3
100 m to 150 m	4
More than 150 m	5

7.9 A total exposure score has been determined for each proposed infrastructure location, by multiplying the three component scores together and taking the cube root of the result. This is considered to provide an appropriate reflection of the overall consequence, or exposure, taking account of receptor sensitivity, proximity, and relative elevation as contributing considerations.

7.10 Where more than one receptor was identified down-gradient from a given proposed source area, the process has been repeated for each receptor, and the highest total exposure score has been used in the assessment related to that particular source (proposed infrastructure element).

7.11 Table 16 gives a qualitative description of the exposure (impact) associated with the scores determined by the above method.

Table 16 – Peat Slide Exposure Categories

Score	Consequence	Exposure (Impact)
1	Minor restoration of works.	Low
2	Blockage of site access roads or local drainage systems.	Low – Medium
3	Damage to rural lands and localised pollution to watercourses.	Medium

Score	Consequence	Exposure (Impact)
4	Blockage of public roads, short to medium term pollution incident.	Medium – High
5	Loss of life, major damage to property, public roads and major pollution incident to watercourses.	High

7.12 Table 17 below provides a summary of the exposure assessment at each of the proposed infrastructure elements.

Table 17 – Peat Slide Exposure Scores

Infrastructure Element	Receptor	Sensitivity Score	Proximity Score	Elevation Score	Total Exposure Score
Turbines (including hardstandings)					
T1	Watercourse (WC) to NE	3	2	2	2.29
T2	WC to S	3	2	2	2.29
T3	SSSI to NW	4	2	3	2.88
T4	Drain to S	3	5	1	2.46
T5	WC to SE	3	2	3	2.62
T6	WC to SE	3	2	3	2.62
T7	SSSI to NW	4	2	3	2.88
T8	WC to E	3	2	3	2.62
T9	T10	4	2	3	2.88
T10	WC to N	3	2	2	2.29
T11	WC to NW	3	2	2	2.29
T12	WC to E	3	4	1	2.29
T13	WC to SE	3	2	2	2.29
T14	Drain to SE	3	5	1	2.46
T15	WC to N	3	2	2	2.29

Infrastructure Element	Receptor	Sensitivity Score	Proximity Score	Elevation Score	Total Exposure Score
T16	WC to N	3	2	2	2.29
T17	WC to N	3	2	2	2.29
T18	WC o S	3	2	2	2.29
T19	WC to S	3	2	2	2.29
T20	WC to N	3	4	1	2.29
T21	WC to SE	3	3	2	2.62
Other Infrastructure					
Met Mast 1	T3	4	2	2	2.52
Met Mast 2	WC to NE	3	2	2	2.29
Substation Compound	WC to E	3	2	1	1.82
Temporary Compound (S)	WC to E	3	2	2	2.29
Temporary Compound (N)	BP-N	1	4	1	1.59
Laydown Area	WC to E	3	3	2	2.62
Borrow Pit Search Area (S)	SSSI to NW	4	2	3	2.88
Borrow Pit Search Area (W)	WC to SW	3	2	2	2.29
Borrow Pit Search Area (N)	WC to SE	3	5	1	2.46
New Access Track Sections					
Track - A	WC to NE	3	3	2	2.62
Track - B	WC to S	3	2	2	2.29

Infrastructure Element	Receptor	Sensitivity Score	Proximity Score	Elevation Score	Total Exposure Score
Track - C	T4	4	2	2	2.52
Track - D	WC to SE	3	4	1	2.29
Track - E	WC to N	3	3	2	2.62
Track - F	WC crossed by track	3	5	1	2.46
Track - G	WC to SE	3	2	3	2.62
Track - H	WC to E	3	2	3	2.62
Track - I	Drain to SE	3	5	1	2.46
Track - J	WC to NW	3	2	2	2.29
Track - K	T11	4	3	1	2.29
Track - L	WC to NE	3	2	2	2.29
Track - M	WC to NE	3	2	2	2.29
Track - N	WC to NE	3	4	1	2.29
Track - O	WC crossed by track	3	5	1	2.46
Track - P	WC to N	3	2	2	2.29
Track - Q	WC to N	3	3	2	2.62
Track - R	WC crossed by track	3	5	1	2.46
Track - S	WC to S	3	3	2	2.62
Track - T	WC to E	3	2	2	2.29

7.13 As shown in the summary table above, the total exposure scores range from 1.59 to 2.88, reflecting the presence of sensitive receptors, tempered by the distance between receptors and source areas and/or the relatively gentle topography in some areas where infrastructure elements have been sited.

Peat Slide Hazard Risk Scoring

7.14 Following the identification of the above hazards and exposure, it is possible to categorise each proposed infrastructure element (i.e. each potential source location) with a risk score, by multiplying the likelihood of failure (Hazard Ranking) by its potential impact (exposure score). The matrix suggested by the Best Practice Guidance to determine the risk category is presented in Table 18 below.

Table 18 – Peat Slide Risk Categories

Peat Slide Hazard Risk Scoring		Action Suggested
1 – 3.99	Negligible	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate
4 – 7.99	Low	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations
8 – 14.99	Medium	Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk score to low or negligible
>=15	High	Avoid project development at these locations

7.15 Table 19 below presents a summary of the assessment of peat slide risk based on the methodology set out above.

Table 19 – Peat Slide Risk

Infrastructure Element	Hazard Ranking	Exposure Score	Risk Score	Risk Category
Turbines (including hardstandings)				
T1	3	2.29	6.86	Low
T2	3	2.29	6.86	Low
T3	2	2.88	5.76	Low
T4	2	2.46	4.93	Low
T5	3	2.62	7.85	Low
T6	3	2.62	7.85	Low
T7	2	2.88	5.76	Low
T8	3	2.62	7.85	Low
T9	2	2.88	5.76	Low
T10	3	2.29	6.86	Low
T11	2	2.29	4.58	Low
T12	2	2.29	4.58	Low

Infrastructure Element	Hazard Ranking	Exposure Score	Risk Score	Risk Category
T13	1	2.29	2.29	Negligible
T14	3	2.46	7.39	Low
T15	2	2.29	4.58	Low
T16	2	2.29	4.58	Low
T17	2	2.29	4.58	Low
T18	3	2.29	6.86	Low
T19	2	2.29	4.58	Low
T20	3	2.29	6.86	Low
T21	2	2.62	5.24	Low
Other Infrastructure				
Met Mast 1	2	2.52	5.04	Low
Met Mast 2	2	2.29	4.58	Low
Substation Compound	3	1.82	5.45	Low
Temporary Compound (S)	2	2.29	4.58	Low
Temporary Compound (N)	3	1.59	4.76	Low
Laydown Area	2	2.62	5.24	Low
Borrow Pit Search Area (S)	3	2.88	8.64	Medium
Borrow Pit Search Area (W)	3	2.29	6.86	Low
Borrow Pit Search Area (N)	2	2.46	4.93	Low
New Access Track Sections				
Track - A	3	2.62	7.85	Low

Infrastructure Element	Hazard Ranking	Exposure Score	Risk Score	Risk Category
Track - B	3	2.29	6.86	Low
Track - C	2	2.52	5.04	Low
Track - D	2	2.29	4.58	Low
Track - E	2	2.62	5.24	Low
Track - F	2	2.46	4.93	Low
Track - G	3	2.62	7.85	Low
Track - H	3	2.62	7.85	Low
Track - I	3	2.46	7.39	Low
Track - J	2	2.29	4.58	Low
Track - K	3	2.29	6.86	Low
Track - L	3	2.29	6.86	Low
Track - M	3	2.29	6.86	Low
Track - N	2	2.29	4.58	Low
Track - O	2	2.46	4.93	Low
Track - P	2	2.29	4.58	Low
Track - Q	2	2.62	5.24	Low
Track - R	2	2.46	4.93	Low
Track - S	3	2.62	7.85	Low
Track - T	3	2.29	6.86	Low

7.16 The summary presented in Table 19 indicates that the risk of peat slide at all proposed infrastructure elements except two is low. The risk at T13 is assessed as having negligible risk, however the southern borrow pit search area is assessed as having a medium risk.

7.17 The assessment has therefore identified that the development, as currently proposed, is suitable for development pending further investigation to refine the assessment and mitigate hazards (see Section 8 for details). The exception is the southern borrow pit search area, however as noted in Chapter 11, this represents an area of search, within which only a proportion would actually be excavated to win stone for the site's construction. No excavation will occur until further site investigations have been undertaken to assess the suitability of the area and refine the assessment of peat slide risk. For example, areas of deeper peat within the search area would be avoided, thereby reducing the peat slide risk. If it is determined that no suitable excavation site within the search area can be identified, then no excavation will occur at that search area.

8 Proposed Development Design and Mitigation

Detailed Design and Site Investigation

8.1 A detailed site investigation would be required to assist detailed design. Intrusive ground investigations would be completed at infrastructure locations prior to construction commencing to ascertain depth to bedrock and suitable founding conditions.

8.2 A detailed stability analysis can then be completed at all infrastructure locations using the increased confidence in the shear strength/peat depth data and site-specific topographical survey data, to provide added robustness to the stability assessment.

Turbines and Hardstandings

8.3 This peat slide hazard risk assessment has identified that all turbines are at low risk locations. However, a specific construction method statement would be produced which would draw on the findings of intrusive investigations. The method statement would detail the exact construction methodology to be used, in line with the Peat Management Plan and taking into account:

- Opportunities for micro-siting turbines to further minimise risk where possible;
- A geotechnical analysis for each turbine base;
- The method of excavation and the location for placing and storing excavated material to ensure that these operations do not give rise to slope or site instability;
- Methodology for storing and watering surface vegetated turves, for re-sodding bare areas;
- Details of how excavated spoil would be stored;
- Avoidance of construction (if possible) on wet areas, flushes and easily eroded soils;
- Adequate drainage design to cater for expected heavy rainfall events; and
- Monitoring of ground movement and water levels.

8.4 The Construction Method Statement would also detail how pumped water from excavated bases would be controlled and monitored to ensure it is appropriately managed and if directed into or conveyed to existing drains/watercourses, to ensure that all have adequate treatment beforehand and capacity to deal with the volumes of water encountered.

Access Tracks

8.5 Areas of deep peat have been avoided wherever possible with respect to access track routing, as described in Chapter 2 of the EIA Report. However, it has not been possible to entirely avoid all areas of deep peat, therefore mitigation measures are set out below.

8.6 In two locations, localised stretches of track are likely to traverse deep peat. These stretches are from or between existing tracks and the routing seeks to ensure best use is made of existing infrastructure, with short lengths of track over deep peat considered preferable to entirely new tracks elsewhere, over shallower peat. If, following detailed pre-construction site investigations and micro-siting, these localised stretches cannot avoid being routed over deep peat, then they will be floated, to avoid the requirement to excavate deep peat. Based on the findings of the peat surveys, it is estimated that approximately 410 m of the new roads would be floated.

8.7 Construction of floated roads would be carried out considering the effects of consolidation and the effect loading would have on stability, hydrology and ecology. Construction would require the placing of a geotextile membrane on existing topsoil and vegetation followed by aggregate layers. Depending on ground conditions identified from further, detailed geotechnical investigations, two or more layers of geotextile would be placed in layers of 300 mm to 500 mm. The access tracks would be capped with layers of Type 1 or similar material. Type 1 is unbound aggregate mixture specified under Clause 803 of the Specification for Highway Works (2016) as suitable for vital load bearing foundation in road construction.

8.8 The following additional mitigation measures would be employed to ensure suitable construction of tracks and minimising risk of instability:

- Road alignments would be micro-sited to further reduce risk where possible and appropriate, based on detailed site investigation findings;
- Roads would be constructed to take the required vehicular loadings, having due regard to overall site stability;
- Machinery and vehicles used in track construction would be operated from the already constructed sections of the road as it progresses;
- Conservative design parameters would be used, taking account of potential impacts of localised deforesting and re-planting;
- Good quality rock would be used to construct roads where applicable;
- Ground movement and water level monitoring would be carried out at all times;
- All machinery and construction methods onsite would be selected with a view to minimising impact on the surrounding habitat; and
- All roads would have sufficiently sized culverts, permeable fill or cross drains at the location of each water crossing, flush or other hydrological feature in order to allow the natural flow of water across the site and prevent ponding and the generation of pore pressures which may initiate instability.

Peat Storage

8.9 The principles of temporary peat storage are discussed in Appendix 7.2 Outline Peat Management Plan. Detailed requirements for any appropriate mitigation measures would be set out in the Construction Environmental Management Plan (CEMP).

8.10 Best practice measures for temporary and permanent peat storage during construction would be followed, in accordance with guidance including Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste (Scottish Renewables and SEPA, 2012). This includes:

- selecting suitable temporary storage areas with relatively low ecological value, and low stability risk i.e. not at the crest of a slope or in areas identified as being at higher risk of instability;
- reuse of temporarily stored peat as soon as possible after excavation;
- dressing and reinstating peat used for road verges and infrastructure batters (as part of site landscaping works) as soon as practicable after construction; and
- suitably limiting the angle of reinstated slopes to reduce run-off and erosion.

Drainage Areas

8.11 Design and construction of a suitable drainage system for the Proposed Development would follow Sustainable Urban Drainage Systems (SUDS) principles and would ensure natural drainage without significant alteration of the hydrological regime of the local site area.

8.12 Any construction activity relating to, or undertaken in the vicinity of watercourses would be carried out in general accordance with relevant SEPA Pollution Prevention Guidelines, The Water Framework Directive (WFD), The Water Environment and Water Services (Scotland) Act 2003 (WEWS) and the Controlled Activities Regulations (CAR) 2011 (as amended).

Borrow Pits

8.13 Pre-construction site investigation works would be undertaken to further assess the borrow pit search areas and to identify the specific excavation locations and extents within the search areas.

This would be based on peat depth and distribution, with deep peat avoided, and suitability of rock for excavation. These further investigations would also establish the method of extraction, determining whether any blasting is required. If blasting is required, further analysis of potential impacts on peat stability in the vicinity would be undertaken and appropriate mitigation stipulated.

Monitoring and Management

8.14 A line of surveyed and levelled pegs and visual monitoring is an acceptable method of monitoring movement adjacent to roads, excavations and stockpile areas.

8.15 Thus, as construction activities commence, the appearance of the area and surrounding land would be monitored visually by installing a line of levelled pegs adjacent to the activity location. Specifically, the following signs would be looked for:

- An increased rate of sinking or tilting;
- The rising of adjacent peat/peaty soils;
- Cracking and lateral movement of the soil surface; and
- A rise in water levels.

8.16 The Principal Contractor would ensure that suitably qualified and experienced construction staff are engaged on the project, including a senior geotechnical engineer with extensive practical knowledge and experience of similar conditions to those at the site. The senior geotechnical engineer would have responsibility for maintaining and actively monitoring a geotechnical risk register for the construction works.

8.17 On a similar note, all staff would undergo a site induction and suitable training relating to construction on peatland sites. This would raise awareness of ground instability indicators, best practice construction techniques, mitigation and emergency procedures. All staff should be responsible for observational monitoring and reporting.

9 Conclusion

9.1 Based on an extensive peat survey programme, the Proposed Development is characterised as a blanket bog site with variable peat depths across the site. The Proposed Development layout, including turbines and associated infrastructure, has been designed to avoid the areas of deep peat wherever possible and areas where peat landslide may occur. Further detailed design would be informed by detailed ground investigations to be undertaken prior to commencement of any works onsite.

9.2 The peat slide risk assessment has identified that all proposed infrastructure elements represent a low peat slide risk, except one section of access track assessed as having a negligible risk, and one borrow pit search area assessed as having a medium risk.

9.3 Mitigation measures are detailed herein which would assist in reduction of any potential risks associated with construction activities causing ground instability, including undertaking detailed intrusive ground investigations to clarify risks and allow stipulation of specific geotechnical mitigation measures and/or micro-siting as required. If, following further investigations and refinement of the risk assessment at the southern borrow pit search area, it is determined that no suitable excavation site can be identified, then no excavation will occur at that search area.

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ANNEX 1 – Peat Depths

ID	X	Y	Depth (cm)
0	275077	633468	80
1	275075	633458	30
2	275075	633448	30
3	275075	633438	20
4	275075	633428	70
5	275075	633418	10
6	275075	633408	60
7	275075	633398	80
8	275075	633388	80
9	275075	633378	50
10	275025	633428	75
11	275035	633428	40
12	275055	633428	50
13	275065	633428	30
14	275115	633428	50
15	275125	633428	75
16	275096	633441	80
17	275362	634862	50
18	275361	634852	130
19	275361	634842	120
20	275411	634861	140
21	275411	634851	195
22	275411	634841	200
23	275461	634859	80
24	275461	634849	90
25	275461	634839	170
26	275511	634858	100
27	275511	634848	85
28	275511	634838	65
29	276598	635367	60
30	276608	635370	60
31	276616	635320	55
32	276626	635324	65
33	276634	635273	70
34	276644	635277	75
35	276652	635227	45
36	276646	635182	60
37	276656	635181	45
38	276666	635179	45
39	276639	635132	60
40	276649	635131	50
41	276659	635130	65
42	276633	635083	65
43	276643	635081	35
44	276653	635080	45
45	276627	635033	80
46	276636	635032	60
47	276646	635031	65
48	276620	634983	80
49	276630	634982	150
50	276640	634981	100
51	276615	634934	60
52	276625	634933	180
53	276635	634932	80
54	276623	634881	50
55	276567	634748	45
56	276567	634738	35

ID	X	Y	Depth (cm)
57	276567	634728	50
58	276517	634738	30
59	276517	634728	55
60	276664	635229	45
61	275105	633420	40
62	275361	634912	30
63	275362	634891	45
64	275414	634923	105
65	275414	634904	115
66	275412	634882	160
67	275463	634883	55
68	275511	634879	75
69	276613	634886	80
70	273780	633222	105
71	273755	633223	92
72	273804	633223	78
73	273779	633248	111
74	273779	633199	56
75	274083	632651	85
76	274082	632678	75
77	274058	632653	40
78	274082	632628	180
79	274107	632653	145
80	275328	635228	53
81	275328	635255	0
82	275303	635230	5
83	275352	635230	5
84	275328	635205	100
85	274330	632489	5
86	274378	632474	107
87	274366	632429	78
88	274342	632436	103
89	274318	632443	25
90	274305	632398	38
91	274353	632384	141
92	275681	634602	189
93	275608	634599	175
94	275542	634593	216
95	274040	632464	131
96	274090	632414	133
97	274042	632364	148
98	273990	632413	116
99	274040	632414	101
100	274037	632977	15
101	273987	632977	67
102	274037	633027	54
103	274087	632976	63
104	274039	632927	68
105	274604	632958	120
106	274604	633008	155
107	274554	632958	90
108	274654	632956	180
109	274605	632908	130
110	275207	633452	45
111	275131	633570	42
112	275097	633481	40
113	275211	633403	55

ID	X	Y	Depth (cm)
114	275257	633450	55
115	275121	633990	64
116	275121	634040	42
117	275071	633990	68
118	275122	633940	79
119	275171	633987	54
120	275915	634864	70
121	275915	634914	30
122	275865	634864	60
123	275965	634863	55
124	275917	634814	35
125	275761	634263	60
126	275761	634313	60
127	275711	634263	50
128	275762	634213	40
129	275811	634262	5
130	275885	635450	60
131	275885	635500	55
132	275835	635449	65
133	275885	635400	70
134	275935	635449	60
135	276722	635294	30
136	276712	635322	55
137	276672	635294	60
138	276725	635244	50
139	276772	635294	90
140	276514	635732	30
141	276514	635782	30
142	276464	635733	65
143	276517	635682	90
144	276564	635730	80
145	276251	636122	160
146	276251	636172	125
147	276201	636123	110
148	276253	636072	60
149	276301	636122	250
150	276409	634660	95
151	276409	634710	60
152	276359	634662	65
153	276410	634610	50
154	276459	634659	40
155	276625	634295	85
156	276625	634345	75
157	276575	634295	80
158	276675	634294	90
159	276627	634245	90
160	276762	633841	55
161	276762	633891	45
162	276712	633843	55
163	276764	633791	20
164	276812	633839	45
165	273992	632364	116
166	273990	632463	48
167	274090	632464	142
168	274092	632365	86
169	273989	632927	20
170	274095	632911	69

ID	X	Y	Depth (cm)
171	274087	633026	20
172	273987	633027	69
173	274554	633008	190
174	274654	633006	130
175	274654	632906	60
176	274554	632908	60
177	275257	633500	54
178	275260	633400	30
179	275002	633394	63
180	275086	633538	78
181	275171	634037	23
182	275171	633937	86
183	275072	633939	65
184	275071	634040	61
185	275711	634313	75
186	275811	634312	60
187	275812	634212	35
188	275226	633213	55
189	275865	634914	55
190	275965	634913	5
191	275967	634813	70
192	275867	634813	40
193	275835	635499	20
194	275935	635499	130
195	275936	635399	60
196	275834	635399	55
197	276772	635344	45
198	276652	635322	60
199	276675	635244	75
200	276764	635225	50
201	276464	635783	10
202	276564	635780	40
203	276569	635682	40
204	276467	635684	80
205	276201	636173	115
206	276301	636172	300
207	276303	636073	185
208	276203	636072	165
209	276359	634712	90
210	276500	634707	55
211	276461	634609	60
212	276360	634613	50
213	276675	634344	50
214	276575	634345	65
215	276577	634244	85
216	276676	634244	75
217	276712	633893	75
218	276812	633889	55
219	276814	633788	40
220	276714	633793	55
221	273764	633400	140
222	273764	633500	35
223	273764	633600	125
224	273764	633700	112
225	273864	633401	72
226	273964	633402	90
227	274064	633402	55

ID	X	Y	Depth (cm)
228	273664	633399	114
229	273564	633405	128
230	273464	633407	175
231	273765	633300	95
232	273748	633111	48
233	275279	634617	138
234	275280	634704	276
235	275280	634804	206
236	275280	634904	117
237	275284	634504	125
238	275288	634404	62
239	275290	634304	85
240	275180	634604	42
241	275080	634609	40
242	274980	634612	166
243	275380	634604	190
244	275480	634600	138
245	275187	635110	248
246	275287	635110	117
247	275387	635110	65
248	275487	635111	98
249	275087	635107	179
250	274987	635106	220
251	274942	635232	277
252	275187	635210	282
253	275187	635310	125
254	275187	635410	75
255	275190	635010	110
256	275191	634910	198
257	275193	634810	213
258	275468	635412	65
259	274886	634811	62
260	275468	634807	169
261	274970	635317	242
262	275039	635245	177
263	275111	635175	214
264	275265	635047	126
265	275339	634980	40
266	275409	634908	121
267	275262	635175	215
268	275391	635330	90
269	274970	634902	137
270	275042	634971	118
271	275126	635030	177
272	275562	634902	113
273	275564	634298	119
274	274980	634307	116
275	275066	634393	104
276	275136	634465	56
277	275212	634531	48
278	275355	634538	240
279	275430	634472	222
280	275492	634392	160
281	275209	634675	141
282	275136	634743	180
283	275080	634768	180
284	275348	634677	30

ID	X	Y	Depth (cm)
285	275416	634750	130
286	273462	633698	65
287	274063	633696	65
288	274065	633103	80
289	273547	633608	80
290	273625	633543	158
291	273693	633470	168
292	273844	633460	158
293	273905	633541	97
294	273976	633612	94
295	273837	633331	80
296	273911	633265	83
297	273980	633191	75
298	273545	633195	92
299	273611	633271	88
300	273693	633329	96
301	275569	635493	120
302	275669	635492	150
303	275568	635343	60
304	275668	635342	80
305	275567	635422	190
306	275669	635421	150
307	275621	635493	55
308	275616	635342	65
309	275770	635400	90
310	275919	635388	40
311	275911	635288	55
312	275761	635301	50
313	275620	635417	115
314	275838	635295	55
315	275765	635348	85
316	275915	635334	70
317	275844	635351	70
318	276034	635263	50
319	276113	635278	40
320	276185	635287	55
321	276185	635213	60
322	276120	635200	50
323	276038	635184	50
324	276028	635233	65
325	276175	635266	70
326	276106	635249	20
327	275778	635268	55
328	275755	635227	255
329	275758	635258	255
330	275804	635222	255
331	275805	635247	260
332	275265	632914	70
333	275264	632941	35
334	275288	632916	107
335	275264	632892	99
336	275239	632916	88
337	275312	632642	80
338	275312	632667	70
339	275287	632643	35
340	275337	632643	60
341	275312	632618	52

ID	X	Y	Depth (cm)
342	274308	632492	50
343	274259	632508	75
344	274279	632400	40
345	274230	632412	55
346	274246	632463	55
347	274291	632447	70
348	274269	632454	70
349	276680	635240	75
350	276780	635240	75
351	276680	635340	50
352	276780	635340	45
353	276480	635640	140
354	276580	635640	55
355	276480	635740	50
356	276580	635740	50
357	276080	636040	130
358	276180	636040	120
359	276280	636040	75
360	276380	636040	40
361	276080	636140	95
362	276180	636140	95
363	276280	636140	170
364	276380	636140	60
365	276180	636240	220
366	276280	636240	215
367	276380	636240	70
368	276280	636340	150
369	276180	634940	100
370	276480	633640	190
371	276780	633840	55
372	276580	634240	85
373	276680	634240	75
374	276380	634340	240
375	276580	634340	45
376	276680	634340	30
377	276380	634640	65
378	275080	633540	20
379	275203	633644	58
380	275280	633640	38
381	275172	633712	34
382	275080	633940	97
383	275180	633940	65
384	275080	634040	43
385	275180	634040	35
386	273780	632240	170
387	273880	632240	138
388	273980	632240	132
389	274080	632240	104
390	274180	632240	130
391	274280	632240	64
392	273780	632340	132
393	273880	632340	59
394	273980	632340	45
395	274080	632340	131
396	274180	632340	115
397	274280	632340	94
398	274380	632340	45

ID	X	Y	Depth (cm)
399	273780	632440	95
400	273880	632440	143
401	273980	632440	85
402	274080	632440	150
403	274180	632440	134
404	274280	632440	127
405	274380	632440	85
406	273780	632540	100
407	273880	632540	139
408	273981	632601	80
409	274080	632540	85
410	274180	632540	15
411	274280	632540	200
412	274380	632540	65
413	274480	632540	45
414	274580	632540	60
415	273780	632640	85
416	273880	632640	63
417	273980	632640	40
418	274080	632640	45
419	274180	632640	90
420	274280	632640	190
421	274380	632640	60
422	274480	632640	45
423	274580	632640	90
424	273780	632740	115
425	273880	632740	68
426	273980	632740	170
427	274080	632740	145
428	274241	632796	40
429	274280	632740	40
430	274380	632740	55
431	274480	632740	100
432	274580	632740	65
433	274680	632740	45
434	273780	632840	62
435	273880	632840	89
436	273980	632840	30
437	273895	632982	112
438	274380	632840	5
439	274480	632840	60
440	274580	632840	80
441	274680	632840	50
442	273780	632940	20
443	273880	632940	123
444	273980	632940	25
445	274095	632911	69
446	274280	632940	113
447	274380	632940	115
448	274480	632940	30
449	274580	632940	90
450	274680	632940	100
451	274780	632940	70
452	273780	633040	39
453	273880	633040	100
454	273980	633040	92
455	274080	633040	44

ID	X	Y	Depth (cm)
456	274239	633037	54
457	274280	633040	62
458	274380	633040	40
459	274480	633040	50
460	274580	633040	55
461	274680	633040	40
462	274780	633040	40
463	273780	633140	35
464	273880	633140	35
465	273980	633140	15
466	274080	633140	55
467	274180	633140	120
468	274280	633140	74
469	274420	633092	15
470	274480	633140	20
471	274580	633140	50
472	274594	633182	10
473	274780	633140	20
474	273780	633240	100
475	273880	633240	98
476	273980	633240	130
477	274080	633240	40
478	274180	633240	40
479	274280	633240	58
480	274380	633240	30
481	274496	633233	5
482	274580	633240	10
483	274707	633223	20
484	274780	633240	65
485	273880	632140	115
486	273980	632140	80
487	274080	632140	100
488	274155	632189	99
489	274880	633040	40
490	275080	634240	55
491	275980	636040	20
492	275980	636140	50
493	276280	636440	45
494	276080	636340	300
495	276180	636340	300
496	276080	636240	300
497	275980	636240	300
498	275980	636340	300
499	275980	636440	300
500	276080	636440	300
501	276180	636440	300
502	276802	634925	23
503	276852	634875	23
504	275905	635269	23
505	277087	635540	90
506	277037	635490	45
507	277037	635590	68
508	276527	635634	23
509	276527	635584	45
510	273962	634055	23
511	275605	635695	45
512	275605	635745	45

ID	X	Y	Depth (cm)
513	275555	635745	45
514	275605	635795	45
515	275655	635745	45
516	275306	635038	90
517	274997	634591	158
518	274906	634622	158
519	275166	634513	68
520	274882	634013	68
521	274792	634098	45
522	274746	634653	113
523	273862	634055	23
524	274827	634642	90
525	275345	635530	45
526	275252	635006	225
527	275366	634713	18
528	275485	635785	45
529	275418	635466	90
530	273912	634105	68
531	275202	635029	113
532	274707	634256	45
533	273966	634013	68
534	273742	633329	18
535	273726	633257	135
536	273832	633420	113
537	275338	634659	293
538	274466	634613	90
539	274493	634517	45
540	274774	633703	68
541	274673	634649	68
542	274687	633643	0
543	275388	634609	203
544	274508	634446	23
545	276866	634913	23
546	276896	634968	23
547	275338	634609	135
548	276266	635213	90
549	275288	634609	18
550	275352	634767	27
551	275386	634656	18
552	275428	634701	158
553	275236	635111	338
554	275312	634722	248
555	275352	634688	135
556	275390	634734	248
557	275503	635469	225
558	275508	635933	45
559	275581	635479	90
560	275666	635613	45
561	275186	635111	135
562	275579	635902	90
563	275457	635390	90
564	275501	635860	45
565	275483	635726	90
566	275639	635517	45
567	275666	635813	45
568	275186	635061	158
569	276166	635013	23

ID	X	Y	Depth (cm)
570	275775	636034	23
571	275709	635965	90
572	274516	634675	68
573	275766	636113	45
574	275866	636213	18
575	275866	636113	27
576	274516	634625	158
577	274657	634206	45
578	274566	634675	90
579	275338	634559	45
580	274466	634675	68
581	273764	633350	18
582	273814	633400	18
583	273764	633400	135
584	274538	633549	23
585	274538	633649	0
586	274757	634206	90
587	274588	633599	0
588	274538	633599	0
589	275876	636373	45
590	274707	634206	90
591	275826	636323	36
592	275776	636373	428
593	275826	636373	383
594	275678	635473	90
595	276477	635634	68
596	276527	635684	90
597	276577	635634	45
598	274707	634156	68
599	275826	636423	45
600	276537	635546	23
601	276525	635493	68
602	276195	634994	18
603	275837	636085	23
604	274557	634692	45
605	273912	634055	90
606	274028	634116	23
607	276221	635285	45
608	276225	634952	248
609	273912	634005	90
610	276225	635002	338
611	275855	635269	27
612	275855	635219	158
613	276175	634952	45
614	276802	634825	23
615	275136	635111	135
616	275186	635161	113
617	276802	634875	45
618	276752	634875	23
619	276151	634892	23
620	275859	635249	248
621	275367	634531	225
622	275102	634535	135
623	275225	634521	45
624	274476	633586	23
625	275477	635315	103
626	275473	635330	65

ID	X	Y	Depth (cm)
627	275482	635302	67
628	275573	635319	90
629	275475	635381	70
630	275575	635380	104
631	275378	635094	55
632	275323	634718	215
633	275339	634896	60
634	275381	635144	90
635	275310	634800	160
636	275397	634654	140
637	275371	635043	75
638	275304	634754	180
639	275362	634993	80
640	275350	634945	60
641	275325	634847	50
642	275335	634844	110
643	275381	635042	50
644	275391	635143	60
645	275320	634797	250
646	275372	634991	60
647	275314	634755	166
648	275348	634894	50
649	275360	634942	50
650	275403	634662	157
651	275367	634691	220
652	275329	634725	210
653	275388	635093	50
654	275392	634645	141
655	273866	633321	128
656	273856	633321	106
657	273856	633311	122
658	273856	633331	157
659	273846	633321	119
660	275570	634762	133
661	275560	634762	135
662	275570	634772	158
663	275580	634762	160
664	275570	634752	143
665	275504	634775	188
666	276514	635256	380
667	274668	634576	44
668	274567	633579	45
669	275413	635310	30
670	274899	634474	121
671	274362	632864	10
672	276556	634913	50
673	274747	633671	55
674	275655	635685	55
675	275719	634427	140
676	275679	634456	110
677	274491	634668	71
678	275821	635452	65
679	276588	634554	115
680	275275	634561	103
681	274412	632952	65
682	273954	634037	115
683	274862	633765	20

ID	X	Y	Depth (cm)
684	275714	636003	45
685	275638	634920	31
686	275643	635782	40
687	276574	634898	85
688	274033	634099	127
689	275671	635386	65
690	274850	634489	25
691	276582	634849	95
692	274271	633054	82
693	274108	634164	26
694	275758	636031	40
695	274942	633816	60
696	274100	632734	80
697	276551	635057	210
698	276492	634259	70
699	274053	632717	209
700	276492	634780	95
701	276494	634330	20
702	275665	635536	50
703	274047	633042	5
704	276733	633897	60
705	274915	633977	88
706	273925	632573	40
707	274851	634048	90
708	275320	634588	176
709	275469	634738	180
710	276533	635155	205
711	274757	634530	90
712	276623	634104	90
713	275448	634635	130
714	276509	635301	280
715	274624	634599	219
716	276712	633992	60
717	274614	633598	58
718	274354	633029	5
719	274006	632701	242
720	276582	634504	40
721	274815	634083	75
722	274788	633701	76
723	274095	633134	89
724	274948	634463	137
725	273994	634067	105
726	276515	634824	190
727	276588	634140	80
728	274704	633644	42
729	275652	635735	30
730	275240	634537	75
731	274009	633009	55
732	275662	635585	70
733	275759	634350	40
734	276521	635204	130
735	276551	634414	70
736	274743	634152	79
737	275669	635436	145
738	274384	632908	50
739	275099	634479	91
740	276572	634457	45

ID	X	Y	Depth (cm)
741	275180	633705	10
742	275221	634563	96
743	276522	634375	10
744	275339	635201	10
745	276538	634869	160
746	276657	634067	80
747	275028	633872	84
748	274305	633025	47
749	273962	632669	60
750	275294	635224	7
751	275362	634613	195
752	276561	634255	65
753	275173	633593	65
754	274987	633839	70
755	274802	634507	148
756	276564	634960	250
757	275175	633525	45
758	275637	635937	60
759	274927	633932	64
760	274176	633089	118
761	275193	634514	85
762	274713	634553	30
763	275530	634813	128
764	275674	635973	65
765	276595	634603	75
766	275231	633818	115
767	276489	635341	280
768	275052	634461	122
769	276726	633944	40
770	275638	634486	40
771	274224	633065	126
772	276595	634750	20
773	274085	633074	10
774	276560	635008	250
775	274707	634182	73
776	274827	633733	45
777	274070	634132	120
778	275766	635446	135
779	276554	634177	80
780	275146	634496	85
781	274535	634645	122
782	274124	633104	89
783	276542	635106	225
784	275374	635271	5
785	275781	634375	75
786	274580	634622	165
787	275555	634857	108
788	275658	635635	65
789	276508	634274	45
790	275060	633913	49
791	275590	634898	40
792	274779	634117	70
793	275360	635218	15
794	275173	633624	30
795	275448	634687	164
796	275727	635422	50
797	274999	634458	20

ID	X	Y	Depth (cm)
798	276691	634030	60
799	275183	633490	45
800	274341	632994	30
801	273933	632625	87
802	276465	634748	90
803	276588	634799	0
804	274660	633619	67
805	275804	636049	80
806	274012	632682	220
807	276562	635110	40
808	276369	634725	80
809	274148	633136	109
810	275046	634480	151
811	275820	635472	65
812	276419	634726	75
813	275139	634515	85
814	275678	635636	45
815	275644	634901	5
816	275000	634478	133
817	276705	634044	90
818	275193	633625	10
819	275650	634502	50
820	275685	635957	55
821	274736	633687	30
822	275392	635261	5
823	276637	634117	70
824	275309	634605	235
825	274402	632899	45
826	276584	634959	250
827	274678	634594	142
828	276511	634265	35
829	275014	633886	86
830	275422	635293	5
831	274607	633617	49
832	276528	635307	50
833	274933	633986	102
834	275687	635486	15
835	275812	634882	70
836	275468	634685	155
837	275692	635336	90
838	276615	634752	65
839	274694	633661	65
840	275691	635387	40
841	274933	633834	116
842	274322	633037	40
843	275572	634847	115
844	274072	633089	133
845	276603	634154	85
846	275193	633673	40
847	274614	634214	66
848	275643	635881	105
849	275268	634580	115
850	274107	632715	88
851	276556	634860	95
852	274811	634525	106
853	276608	634551	115
854	273951	632530	40

ID	X	Y	Depth (cm)
855	275758	635465	85
856	274856	634508	70
857	276568	634404	40
858	274865	634063	80
859	275714	635437	150
860	276538	634363	20
861	275229	634554	70
862	274098	633154	40
863	275092	634497	112
864	274113	633121	95
865	276579	635011	170
866	276621	634650	40
867	275682	635586	70
868	275519	634761	205
869	274379	632854	5
870	275548	634804	166
871	274057	634147	125
872	276553	635159	55
873	276746	633950	70
874	275070	633966	60
875	275765	636013	30
876	274848	633779	32
877	274589	634640	178
878	276569	634190	90
879	274901	634028	88
880	274341	633045	10
881	276671	634081	80
882	273945	632571	60
883	276473	634730	70
884	274793	634132	74
885	275380	635220	98
886	276541	635207	260
887	275352	634631	178
888	275689	635436	180
889	275468	634637	180
890	274633	634617	223
891	274095	634180	55
892	275732	634442	30
893	275675	635686	65
894	276602	634502	20
895	274977	633856	42
896	275672	635736	45
897	275348	635219	21
898	274951	634483	136
899	273943	632525	70
900	274230	633084	88
901	276731	633997	75
902	274757	634166	57
903	273952	632617	87
904	276534	635254	175
905	274903	634493	128
906	276513	634324	20
907	274947	633934	66
908	274280	633072	40
909	274060	632698	120
910	275734	634375	45
911	275043	633924	10

ID	X	Y	Depth (cm)
912	275812	636030	20
913	276504	635354	260
914	276522	634288	45
915	274829	634097	98
916	275726	635986	55
917	275485	634725	197
918	276510	634771	60
919	275685	635536	80
920	275602	634882	52
921	274767	634548	89
922	274776	633716	60
923	275651	635923	75
924	276614	634601	65
925	275097	634008	70
926	274814	633748	30
927	276571	635060	55
928	275194	633596	30
929	275662	635787	60
930	273977	632656	132
931	275186	634533	100
932	276576	634908	130
933	274722	634571	260
934	276594	634900	90
935	275204	633720	10
936	274189	633104	71
937	274651	633637	41
938	276458	635383	60
939	276608	634802	80
940	274717	634200	94
941	274321	632990	50
942	275418	635301	10
943	275383	635266	0
944	275370	635219	5
945	274097	633144	110
946	274144	633127	130
947	274183	633096	102
948	274227	633075	167
949	274276	633063	60
950	274313	633031	69
951	274331	632992	10
952	274347	633037	10
953	275808	636040	40
954	275761	636022	40
955	275720	635995	55
956	275680	635965	80
957	275644	635930	45
958	275634	635882	65
959	275653	635785	40
960	275662	635736	50
961	275665	635686	45
962	275668	635636	65
963	275672	635586	70
964	275675	635536	75
965	275679	635436	130
966	275681	635386	40
967	275682	635336	90
968	275720	635430	75

ID	X	Y	Depth (cm)
969	275762	635456	185
970	276455	635374	60
971	276497	635347	280
972	276519	635304	50
973	276524	635255	280
974	276531	635205	230
975	276543	635157	190
976	276552	635108	100
977	276561	635059	150
978	276570	635009	215
979	276574	634960	220
980	276566	634910	170
981	276547	634864	150
982	276524	634820	160
983	276501	634775	60
984	276469	634739	80
985	276369	634735	60
986	276584	634899	60
987	276598	634801	50
988	276605	634751	45
989	276612	634701	30
990	276611	634652	70
991	276604	634602	65
992	276598	634552	115
993	276592	634503	20
994	276582	634454	45
995	276560	634409	40
996	276530	634369	10
997	276503	634327	10
998	276515	634281	45
999	276501	634262	65
1000	276562	634183	80
1001	276596	634147	85
1002	276630	634110	80
1003	276664	634074	70
1004	276698	634037	90
1005	276721	633995	60
1006	276736	633947	60
1007	275223	634573	105
1008	275272	634571	160
1009	275314	634596	230
1010	275357	634622	162
1011	274540	634654	80
1012	274584	634631	178
1013	274629	634608	240
1014	274673	634585	125
1015	274718	634562	72
1016	274762	634539	32
1017	274806	634516	137
1018	274853	634499	20
1019	274901	634483	130
1020	274950	634473	156
1021	274999	634468	191
1022	275049	634471	105
1023	275096	634488	125
1024	275143	634505	89
1025	275189	634523	91

ID	X	Y	Depth (cm)
1026	275234	634545	84
1027	275644	634494	100
1028	275777	634383	40
1029	275759	634399	45
1030	274938	633825	20
1031	274982	633848	57
1032	275021	633879	85
1033	275051	633919	28
1034	275078	633961	75
1035	275105	634003	26
1036	274712	634191	90
1037	274750	634159	79
1038	274786	634124	77
1039	274822	634090	58
1040	274858	634055	86
1041	274894	634021	88
1042	274924	633981	111
1043	274937	633933	31
1044	275239	633812	130
1045	275194	633701	10
1046	275183	633625	40
1047	275183	633594	65
1048	274610	633607	50
1049	274656	633628	48
1050	274699	633652	80
1051	274742	633679	28
1052	274821	633740	49
1053	274855	633772	57
1054	274393	632903	55
1055	274370	632859	5
1056	274079	633081	115
1057	274118	633112	125
1058	274104	632724	99
1059	274057	632708	176
1060	274009	632692	158
1061	273969	632663	40
1062	273943	632621	30
1063	273935	632572	56
1064	274026	634107	65
1065	274064	634139	105
1066	274102	634172	149
1067	275343	635210	8
1068	275641	634911	20
1069	275596	634890	41
1070	275564	634852	65
1071	275539	634809	142
1072	275511	634768	207
1073	275477	634732	197
1074	275458	634686	185
1075	275458	634636	127
1076	273949	632462	93
1077	273938	632521	49
1078	273914	632497	70
1079	273943	632490	75
1080	273927	634077	90
1081	273965	634106	116
1082	273983	634079	116

ID	X	Y	Depth (cm)
1083	273955	634078	95
1084	274613	634197	32
1085	274660	634194	97
1086	274660	634161	72
1087	274613	634164	15
1088	274613	634204	68
1089	273706	633409	148
1090	273737	633446	58
1091	273731	633388	146
1092	273735	633417	30
1093	274040	633052	20
1094	274021	633078	38
1095	274011	633050	20
1096	274454	632920	100
1097	274429	632942	85
1098	274456	632949	60
1099	274560	634646	140
1100	274577	634672	160
1101	274546	634670	79
1102	275190	634595	80
1103	275201	634623	125
1104	275247	634604	101
1105	275233	634576	80
1106	275218	634599	108
1107	275275	635206	10
1108	275332	635215	11
1109	275316	635185	186
1110	275303	635211	137
1111	276338	635358	115
1112	276339	635279	60
1113	276390	635339	35
1114	276375	634777	70
1115	276372	634745	95
1116	276423	634777	110
1117	276424	634744	70
1118	276208	636045	135
1119	276206	636015	40
1120	276258	636043	110
1121	276257	636012	105
1122	275609	635807	40
1123	275635	635814	60
1124	275622	635763	50
1125	275648	635768	40
1126	275629	635788	30
1127	276565	634265	75
1128	276568	634276	40
1129	275088	633956	62
1130	274512	633604	48
1131	274523	633576	65
1132	274558	633622	55
1133	274568	633594	73
1134	275191	633504	170
1135	275221	633525	70
1136	275227	633520	50
1137	275821	635461	65
1138	276743	633899	40
1139	276753	633902	50

ID	X	Y	Depth (cm)
1140	276740	633855	40
1141	273922	632452	30
1142	273972	632452	99
1143	273972	632482	142
1144	274012	632452	40
1145	273972	632492	58
1146	274002	632452	61
1147	273972	632402	141
1148	274022	632452	116
1149	273972	632502	89
1150	273981	633049	60
1151	273971	632992	65
1152	274011	633022	35
1153	273971	633072	10
1154	273971	632972	40
1155	273921	633022	75
1156	273971	632982	60
1157	274001	633022	40
1158	273971	633022	65
1159	273971	633002	30
1160	274021	633022	71
1161	273762	633422	150
1162	274485	632982	55
1163	274455	632982	45
1164	274485	633022	35
1165	274535	632982	170
1166	274465	632982	45
1167	274485	633012	90
1168	274485	633002	100
1169	274445	632982	75
1170	274485	632952	40
1171	274421	632947	80
1172	275207	633452	90
1173	275157	633452	75
1174	275227	633520	55
1175	275196	633452	75
1176	275177	633452	75
1177	275187	633452	80
1178	274498	633635	98
1179	274562	633588	39
1180	274538	633585	61
1181	274448	633585	48
1182	274498	633585	30
1183	274498	633535	43
1184	273914	634053	112
1185	273944	634053	113
1186	274592	634204	96
1187	274666	634211	70
1188	274592	634134	78
1189	274592	634234	72
1190	274642	634184	65
1191	274662	634202	79
1192	274592	634194	95
1193	274592	634214	91
1194	274592	634184	85
1195	274542	634184	76
1196	274592	634161	76

ID	X	Y	Depth (cm)
1197	275101	633990	96
1198	275115	633998	77
1199	275081	633990	59
1200	275091	633990	69
1201	275737	634243	50
1202	275721	634263	30
1203	275175	634590	20
1204	275175	634616	20
1205	275225	634616	110
1206	275175	634666	155
1207	275175	634580	83
1208	275175	634600	15
1209	275125	634616	165
1210	274456	634697	76
1211	274446	634697	117
1212	274466	634697	30
1213	274504	634682	79
1214	274504	634647	77
1215	274551	634697	48
1216	274504	634747	68
1217	274504	634697	78
1218	274504	634672	77
1219	274504	634662	45
1220	275267	635224	1
1221	275267	635254	67
1222	275227	635234	75
1223	275267	635284	78
1224	275317	635234	60
1225	275247	635234	56
1226	275267	635264	59
1227	275217	635234	86
1228	275267	635184	183
1229	275267	635194	160
1230	275267	635274	61
1231	275267	635234	40
1232	275257	635234	10
1233	275267	635214	2
1234	275277	635234	31
1235	275237	635234	70
1236	275287	635234	4
1237	275267	635244	90
1238	275267	635204	5
1239	275885	635460	160
1240	275885	635470	65
1241	275885	635450	80
1242	275639	635837	40
1243	275665	635837	60
1244	275615	635837	65
1245	275649	635837	65
1246	275565	635837	110
1247	275615	635887	85
1248	275615	635787	30
1249	275629	635837	40
1250	276250	636033	150
1251	276300	636033	45
1252	276280	636053	75
1253	276260	636033	115

ID	X	Y	Depth (cm)
1254	276270	636033	85
1255	276280	636003	55
1256	276280	635993	20
1257	276240	636033	125
1258	276330	636033	65
1259	276280	636033	60
1260	276290	636033	50
1261	276280	636073	160
1262	276280	636013	40
1263	276280	635983	40
1264	276280	636063	120
1265	276230	636033	100
1266	276280	636083	195
1267	276280	636023	95
1268	276320	636033	70
1269	276310	636033	55
1270	276400	635319	110
1271	276420	635359	50
1272	276395	635346	55
1273	276400	635349	50
1274	276430	635359	50
1275	276400	635339	60
1276	276350	635359	85
1277	276450	635359	45
1278	276366	635359	85
1279	276410	635359	50
1280	276440	635359	105
1281	276400	635399	40
1282	276400	635309	110
1283	276400	635379	20
1284	276386	635340	70
1285	276400	635329	60
1286	276400	635389	40
1287	276400	635409	50
1288	276351	634720	90
1289	276328	634734	70
1290	276328	634724	70
1291	276401	634760	110
1292	276301	634760	70
1293	276328	634744	60
1294	276351	634810	185
1295	276351	634760	50
1296	276627	634261	90
1297	276627	634281	90
1298	276627	634271	90
1299	276730	633856	40
1300	276748	633854	60
1301	274570	634184	120
1302	274619	634184	68
1303	276598	633761	45
1304	276547	633766	20
1305	276736	633817	5
1306	276348	633775	70
1307	276720	633829	30
1308	276648	633782	40
1309	276693	633794	50
1310	276448	633785	60

ID	X	Y	Depth (cm)
1311	276598	633781	45
1312	276249	633762	80
1313	276398	633780	75
1314	275691	634895	15
1315	276699	633775	60
1316	276498	633789	60
1317	276550	633786	20
1318	276299	633768	60
1319	276250	633752	80
1320	275690	634915	38
1321	276300	633758	60
1322	276349	633765	70
1323	276399	633770	115
1324	276449	633775	60
1325	276499	633779	50
1326	276548	633776	20
1327	276251	633742	90
1328	276598	633771	45
1329	276648	633772	30
1330	276696	633785	50
1331	276728	633823	20
1332	276351	633755	115
1333	275691	634905	10
1334	276648	633762	30
1335	275865	634774	15
1336	275894	634789	10
1337	276400	633760	115
1338	275740	634891	5
1339	275740	634901	25
1340	275740	634911	10
1341	276500	633769	50
1342	275793	634840	41
1343	275843	634890	38
1344	275843	634840	50
1345	275833	634840	55
1346	275823	634840	48
1347	275843	634790	60
1348	275893	634840	50
1349	275813	634840	52
1350	275843	634800	20
1351	275843	634810	25
1352	275785	634881	15
1353	275790	634889	47
1354	275780	634872	28
1355	275877	634757	7
1356	275860	634747	10
1357	275869	634752	19
1358	276301	633749	115
1359	276450	633765	90
1360	276161	633719	60
1361	276199	633724	60

ANNEX 2 – Hazard Scoring

Infrastructure Element	Depth Score	Slope Score	Substrate Score	Geomorph Score	Drainage Score	Forestry Score	Relief Score	Land Use Score	Total Hazard Score	Hazard Ranking	Hazard (Likelihood)
Turbines (including hardstandings)											
T1	3	3	1	1	3	1	0	0	12	3	Moderate
T2	3	3	1	1	3	1	0	0	12	3	Moderate
T3	3	3	1	1	3	0	0	0	11	2	Low
T4	3	3	1	1	1	1	0	0	10	2	Low
T5	3	3	1	1	3	2	0	0	13	3	Moderate
T6	1	3	1	1	3	3	0	0	12	3	Moderate
T7	3	3	1	1	0	3	0	0	11	2	Low
T8	3	3	1	1	3	1	3	0	15	3	Moderate
T9	3	3	1	1	1	1	0	0	10	2	Low
T10	3	3	1	1	3	1	0	0	12	3	Moderate
T11	3	2	1	1	1	1	2	0	11	2	Low
T12	3	2	1	1	1	1	2	0	11	2	Low
T13	1	3	1	1	0	0	0	0	6	1	Very Low
T14	3	3	1	1	3	2	0	0	13	3	Moderate
T15	3	2	1	1	3	1	0	0	11	2	Low
T16	3	2	1	1	1	1	0	0	9	2	Low
T17	3	2	1	1	3	1	0	0	11	2	Low
T18	3	2	1	1	3	3	0	0	13	3	Moderate
T19	3	0	1	1	0	1	0	2	8	2	Low
T20	3	3	1	1	1	0	3	0	12	3	Moderate
T21	3	3	1	1	1	0	0	0	9	2	Low
Other Infrastructure											
Met Mast 1	3	0	1	1	3	0	0	0	8	2	Low
Met Mast 2	3	0	1	1	3	1	2	0	11	2	Low
Substation	3	2	1	1	3	1	2	0	13	3	Moderate
Temp Comp S	3	2	1	1	0	3	0	0	10	2	Low
Temp Comp N	3	3	1	1	3	1	2	0	14	3	Moderate
Laydown	3	3	1	1	1	1	0	0	10	2	Low
BP South	3	3	1	1	1	1	0	2	12	3	Moderate
BP West	3	3	1	1	3	0	0	2	13	3	Moderate
BP North	3	2	1	1	1	1	2	0	11	2	Low
New Track Sections											
Track - A	3	3	1	1	3	1	0	0	12	3	Moderate
Track - B	3	3	1	1	3	1	0	0	12	3	Moderate
Track - C	3	3	1	1	0	1	0	0	9	2	Low
Track - D	3	3	1	1	1	1	0	0	10	2	Low
Track - E	3	3	1	1	1	1	0	0	10	2	Low
Track - F	3	3	1	1	1	1	0	0	10	2	Low
Track - G	1	3	1	1	3	3	0	0	12	3	Moderate
Track - H	3	3	1	1	3	1	3	0	15	3	Moderate
Track - I	3	3	1	1	3	2	3	0	16	3	Moderate
Track - J	3	2	1	1	0	1	2	0	10	2	Low
Track - K	3	3	1	1	3	1	0	0	12	3	Moderate
Track - L	2	2	1	1	3	1	2	0	12	3	Moderate
Track - M	3	2	1	1	3	1	2	0	13	3	Moderate
Track - N	1	2	1	1	1	1	2	0	9	2	Low
Track - O	1	2	1	1	1	0	2	0	8	2	Low
Track - P	3	3	1	1	1	1	0	0	10	2	Low
Track - Q	3	2	1	1	1	1	0	0	9	2	Low
Track - R	3	2	1	1	3	1	0	0	11	2	Low
Track - S	3	3	1	1	3	1	0	0	12	3	Moderate
Track - T	3	3	1	1	1	0	3	0	12	3	Moderate

ANNEX 3 – Laboratory Results

Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number:	20/07568	
Issue Number:	1	**Date:** 23 September, 2020

Client: Energised Environments Ltd
7 Dundas Street
Edinburgh
EH3 6QG

Project Manager:	Sarah Tullie
Project Name:	Cumberhead West Wind Farm
Project Ref:	2694
Order No:	EE131692
Date Samples Received:	07/09/20
Date Instructions Received:	09/09/20
Date Analysis Completed:	23/09/20

Prepared by:

[redacted]

Sophie France
Client Service Manager

Approved by:

[redacted]

Richard Wong
Client Manager

1247

Envirolab Job Number: 20/07568

Client Project Name: Cumberhead West Wind Farm

Client Project Ref: 2694

Lab Sample ID	20/07568/1	20/07568/2	20/07568/3	20/07568/4	20/07568/5	20/07568/6	20/07568/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	T2	T4	T5	T1	T7	T9	T10			
Depth to Top	0.65			0.99	1.12	0.85				
Depth To Bottom										
Date Sampled	02-Sep-20	01-Sep-20	02-Sep-20	02-Sep-20	02-Sep-20	02-Sep-20	02-Sep-20			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Sample Matrix Code	6AE	6AE	5AE	6AE	6AE	6AE	6AE			
% Natural Moisture Content (NMC) at 40C$_A$	83.8	87.2	68.4	65.6	41.5	51.7	49.6	% w/w	0.1	A-T-044
% Moisture at 105C$_A$	77.2	52.3	72.0	89.1	82.4	87.6	82.0	% w/w	0.1	A-T-044
% Natural Moisture Content (NMC) at 105C$_A$	337.9	109.6	256.5	819.1	469.6	708.4	455.7	% w/w	0.1	A-T-044
% Stones >10mm$_A$	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	% w/w	0.1	A-T-044
Total Organic Carbon$_D^{M\#}$	5.32	4.12	4.31	50.7	58.2	53.1	55.7	% w/w	0.03	A-T-032s
Total Carbon$_D$	6.1	4.6	5.4	50.7	58.9	53.1	55.7	% w/w	0.1	A-T-032s
Density (soil)$_A$	0.7	IS	IS	IS	0.7	0.6	0.8	g/ml	0.1	Gravimetry - AR

Envirolab Job Number: 20/07568

Client Project Name: Cumberhead West Wind Farm

Client Project Ref: 2694

Lab Sample ID	20/07568/8	20/07568/9	20/07568/10	20/07568/11	20/07568/12			Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	T13	T15	T16	T17	T19					
Depth to Top	0.50				0.68					
Depth To Bottom										
Date Sampled	02-Sep-20	01-Sep-20	02-Sep-20	03-Sep-20	01-Sep-20					
Sample Type	Soil	Soil	Soil	Soil	Soil					
Sample Matrix Code	6AE	6AE	5AE	6AE	6AE					
% Natural Moisture Content (NMC) at 40C$_A$	28.5	80.6	39.0	13.2	82.1			% w/w	0.1	A-T-044
% Moisture at 105C$_A$	72.8	79.2	29.1	80.0	87.4			% w/w	0.1	A-T-044
% Natural Moisture Content (NMC) at 105C$_A$	267.2	380.7	41.0	399.2	691.1			% w/w	0.1	A-T-044
% Stones >10mm$_A$	<0.1	<0.1	<0.1	<0.1	<0.1			% w/w	0.1	A-T-044
Total Organic Carbon$_D$$^{M\#}$	21.8	40.4	1.13	45.7	48.6			% w/w	0.03	A-T-032s
Total Carbon$_D$	20.7	42.3	1.4	46.9	50.6			% w/w	0.1	A-T-032s
Density (soil)$_A$	0.7	IS	IS	IS	IS			g/ml	0.1	Gravimetry - AR

REPORT NOTES

General

This report shall not be reproduced, except in full, without written approval from Envirolab.
The results reported herein relate only to the material supplied to the laboratory.
The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.
The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:

All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,
E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Envirolab Deviating Samples Report

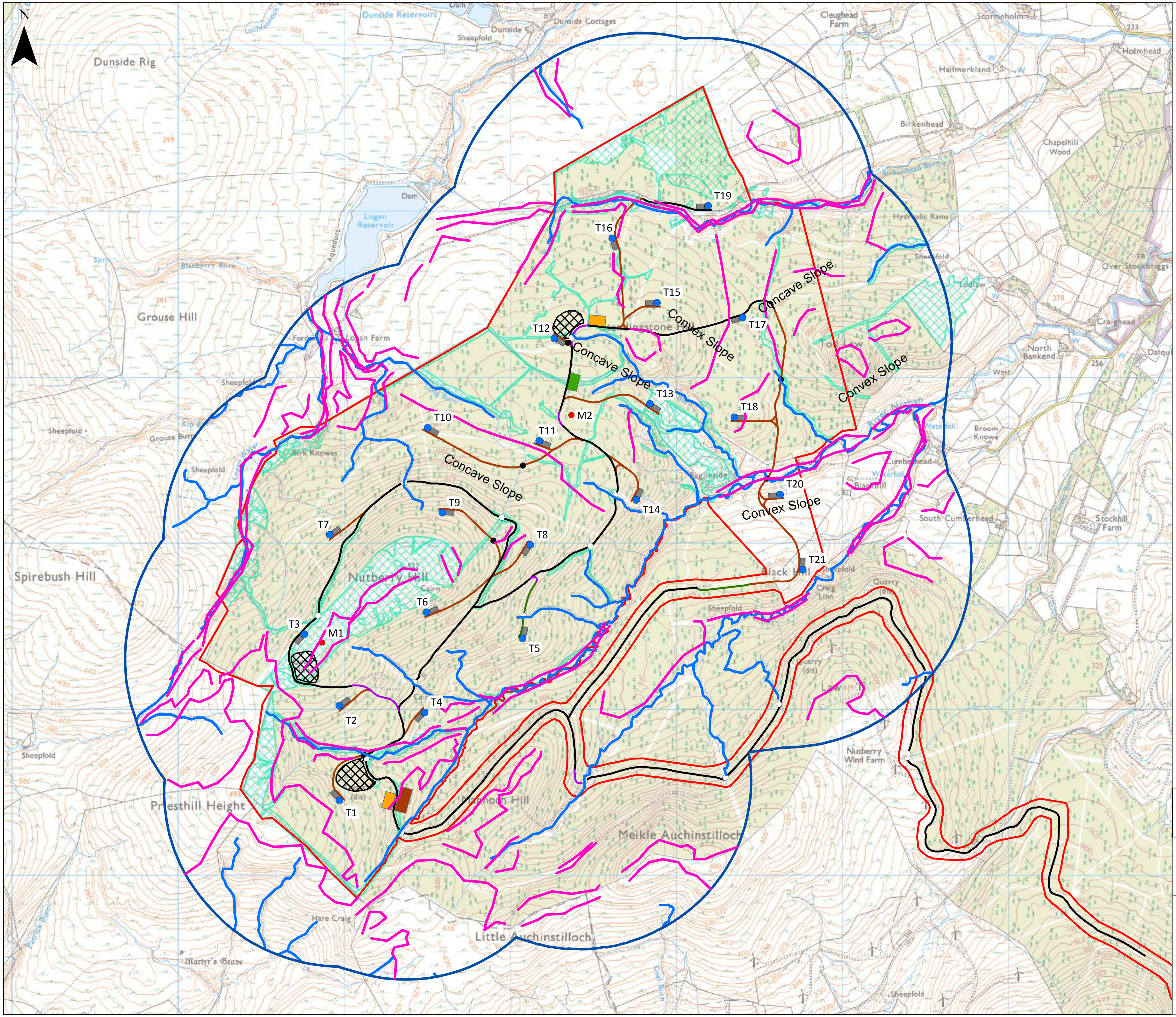
Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. [redacted] email. [redacted]

Client:	Energised Environments Ltd, 7 Dundas Street, Edinburgh, EH3 6QG	**Project No:**	20/07568
		Date Received:	09/09/2020 (am)
Project:	Cumberhead West Wind Farm	**Cool Box Temperatures (°C):**	15.4
Clients Project No:	2694		

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

FIGURES



KEY

- Site Boundary
- Hydrology Study Area
- Proposed Turbine Location
- Indicative Met Mast Location
- Proposed Hardstanding
- Proposed Substation, Control Room & Energy Storage Compound
- Proposed Temporary Compound
- Temporary Turbine Component Laydown Area
- Existing Water Crossing
- Existing Water Crossing to be Upgraded
- New Water Crossing
- Existing Access Track
- Existing Access Track to be Upgraded
- Indicative New Access Track
- Indicative Straightened Access Track
- Potential Borrow Pit Search Area
- Watercourse/Major Drainage Feature
- Bog/Flush/Marsh Habitats
- Main Slope Breaks

0 0.5 1 km

Scale 1:22,000 @ A3

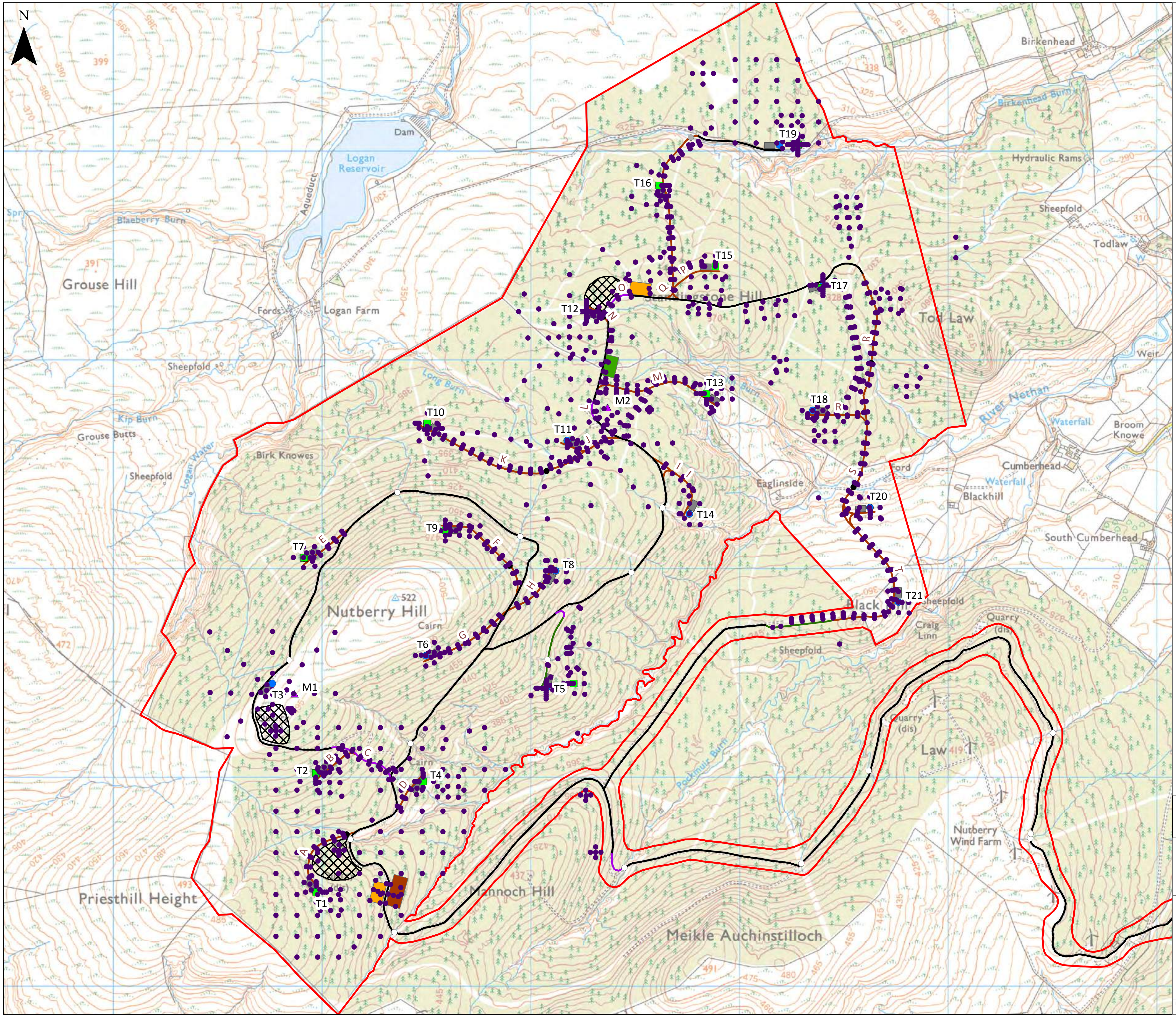
Cumberhead West Wind Farm
Environmental Impact Assessment Report

Appendix 11.1 Figure 1

Geomorphological Features

Date:	Drawn by:	Checked by:	Version:
28/10/2020	ST	JH	V1

Project Number: 2694



KEY

- Site Boundary
- Proposed Turbine Locations
- Indicative Met Mast Location
- Proposed Turbine Laydown Area
- Proposed Substation, Control Room & Energy Storage Compound
- Proposed Temporary Compound
- Temporary Turbine Component Laydown Area
- Existing Water Crossing
- Existing Water Crossing to be Upgraded
- New Water Crossing
- Existing Access Track
- Existing Access Track to be Upgraded
- Indicative Straightened Access Track
- Indicative New Access Track
- A Track Identifier
- Potential Borrow Pit Search Areas
- Peat Probe Location
- Peat Probe and Auger Sample Location

0 0.5 1 km

Scale 1:17,500 @ A3

3R Energy SCOTTISHPOWER RENEWABLES ITPENERGISED

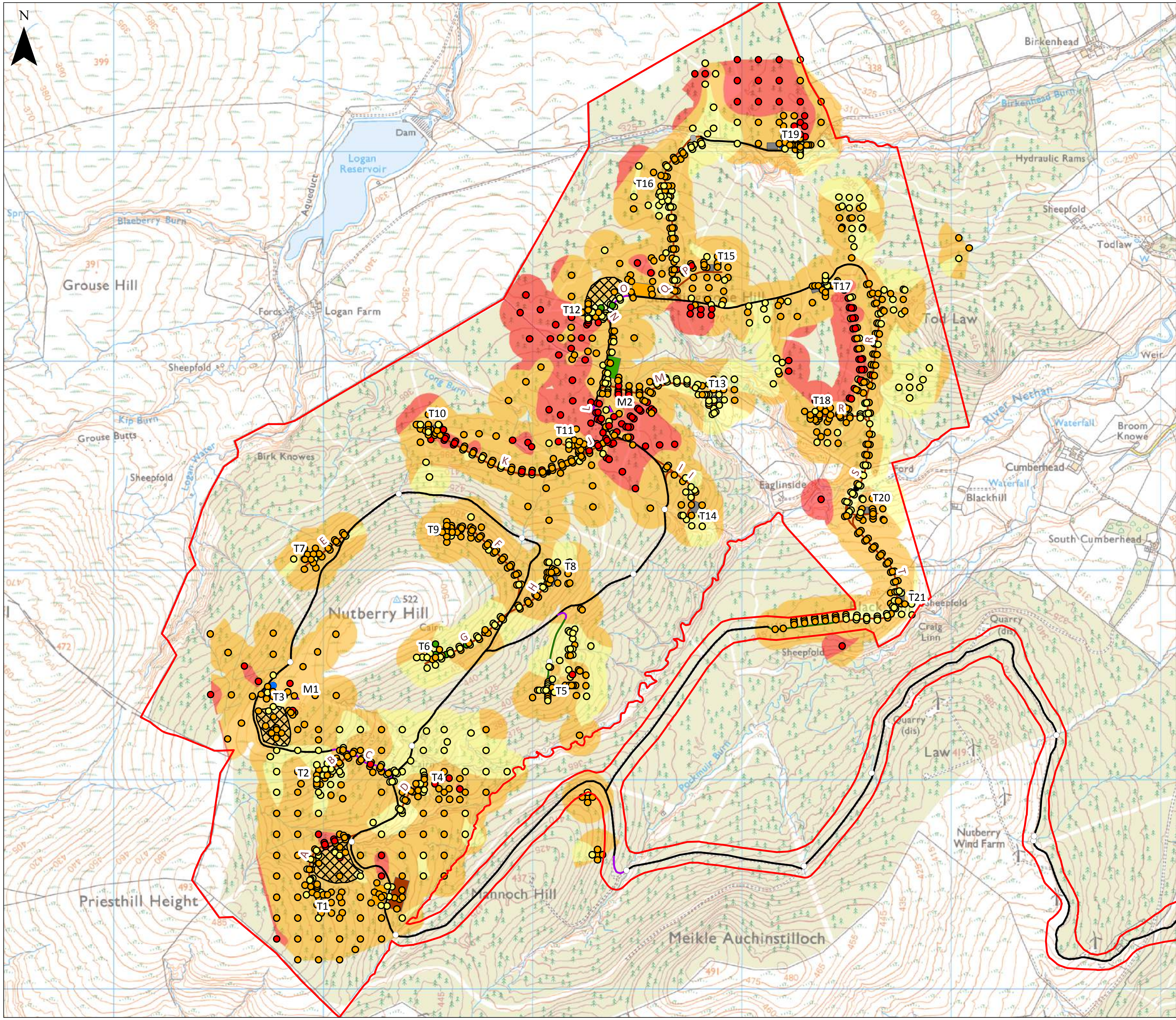
Cumberhead West Wind Farm
Environmental Impact Assessment Report

Appendix 11.1 Figure 2

Peat Survey Points

Date:	Drawn by:	Checked by:	Version:
26/10/2020	ST	JH	V1

Project Number: 2694



KEY

- Site Boundary
- Proposed Turbine Locations
- Indicative Met Mast Location
- Proposed Hardstanding
- Proposed Substation, Control Room & Energy Storage Compound
- Proposed Temporary Compound
- Temporary Turbine Component Laydown Area
- Existing Water Crossing
- Existing Water Crossing to be Upgraded
- New Water Crossing
- Existing Access Track
- Existing Access Track to be Upgraded
- Indicative Straightened Access Track
- Indicative New Access Track
- A Track Identifier
- Potential Borrow Pit Search Areas

Peat Depth (cm)

- Nil
- 1 - 50
- 51 - 150
- >150

Peat Depth Contour (cm)

- NIL
- 1-50
- 51-150
- >150

0 0.5 1 km

Scale 1:17,500 @ A3

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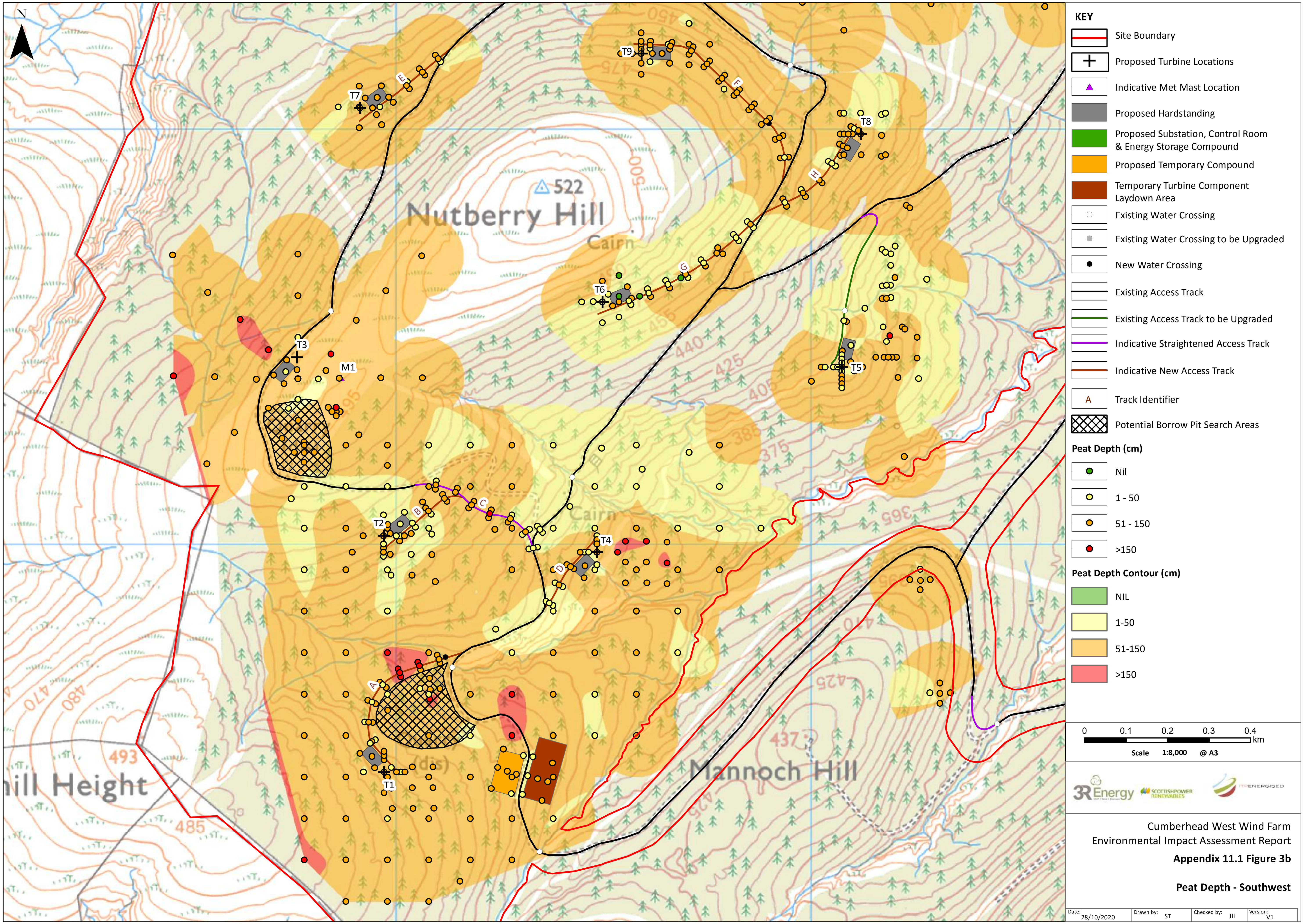
Environmental Impact Assessment Report

Appendix 11.1 Figure 3a

Peat Depth - Site Overview

Date:	Drawn by:	Checked by:	Version:
28/10/2020	ST	JH	V1

Project Number: 2694



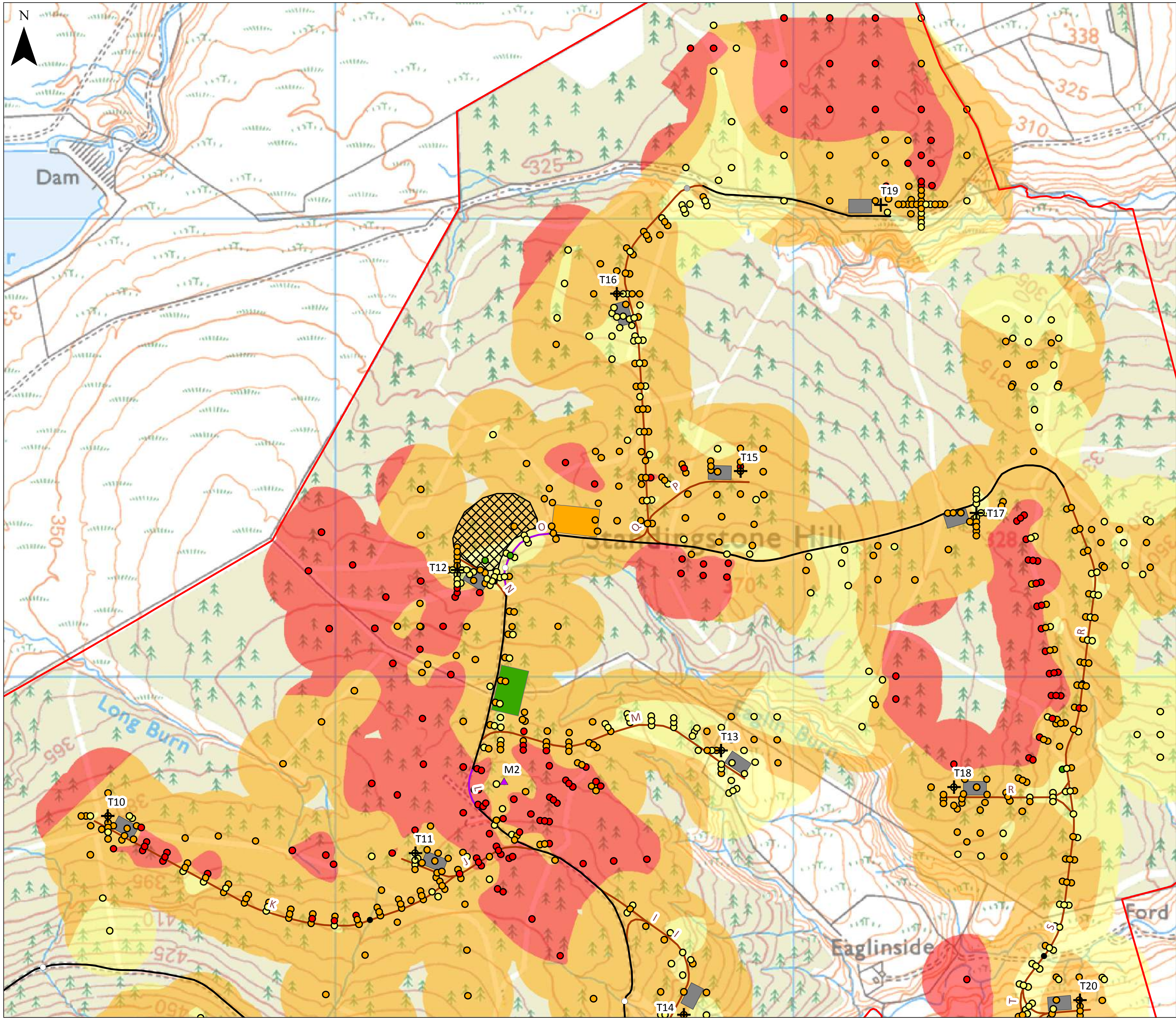
Cumberhead West Wind Farm
Environmental Impact Assessment Report

Appendix 11.1 Figure 3b

Peat Depth - Southwest

Date:	Drawn by:	Checked by:	Version:
28/10/2020	ST	JH	V1

Project Number: 2694



KEY

- Site Boundary
- Proposed Turbine Locations
- Indicative Met Mast Location
- Proposed Hardstanding
- Proposed Substation, Control Room & Energy Storage Compound
- Proposed Temporary Compound
- Temporary Turbine Component Laydown Area
- Existing Water Crossing
- Existing Water Crossing to be Upgraded
- New Water Crossing
- Existing Access Track
- Existing Access Track to be Upgraded
- Indicative Straightened Access Track
- Indicative New Access Track
- A Track Identifier
- Potential Borrow Pit Search Areas

Peat Depth (cm)

- Nil
- 1 - 50
- 51 - 150
- >150

Peat Depth Contour (cm)

- NIL
- 1-50
- 51-150
- >150

0 0.1 0.2 0.3 0.4 km

Scale 1:8,000 @ A3

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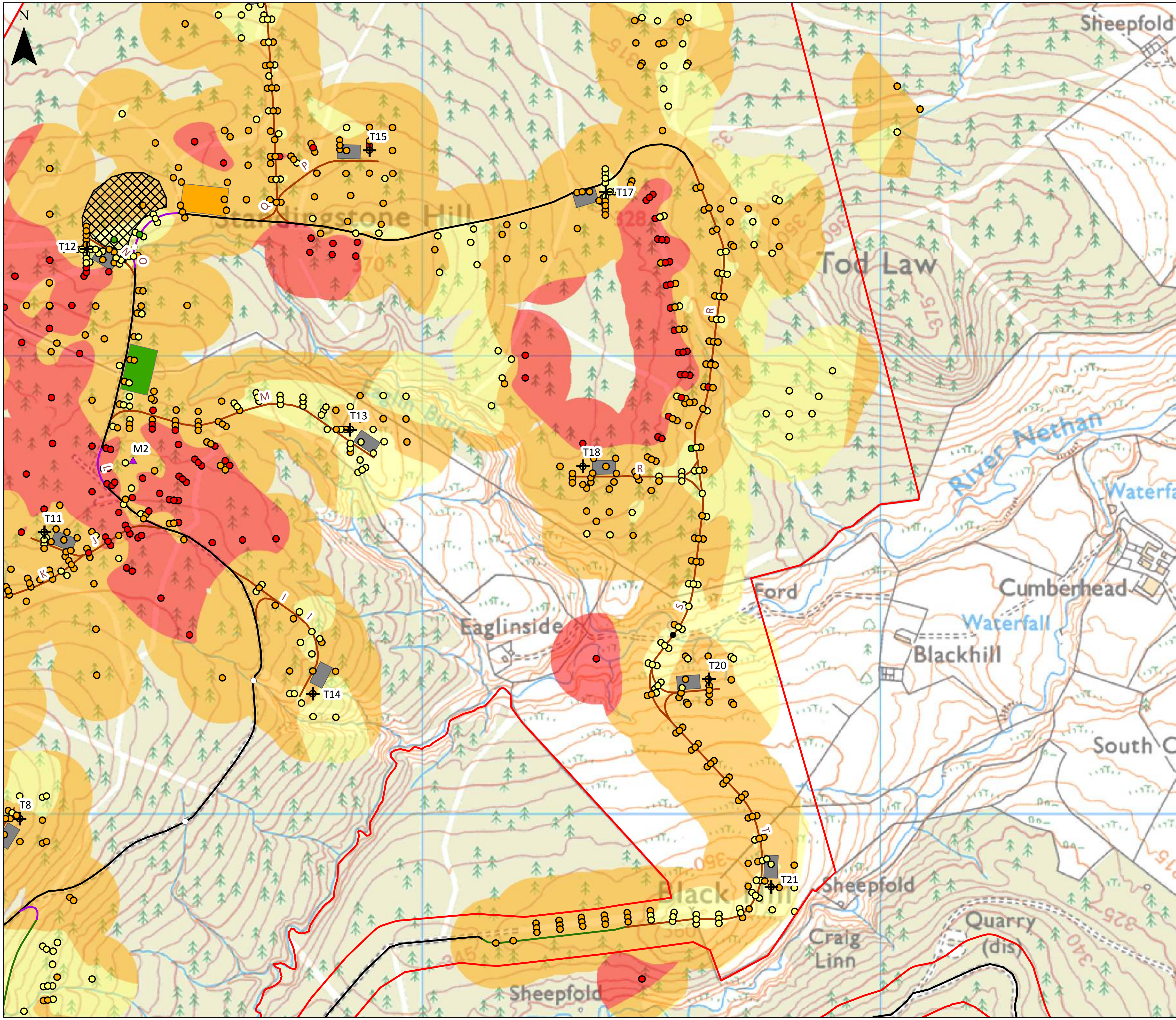
Environmental Impact Assessment Report

Appendix 11.1 Figure 3c

Peat Depth - Centre and North

Date:	Drawn by:	Checked by:	Version:
28/10/2020	ST	JH	V1

Project Number: 2694



KEY

- Site Boundary
- Proposed Turbine Locations
- Indicative Met Mast Location
- Proposed Hardstanding
- Proposed Substation, Control Room & Energy Storage Compound
- Proposed Temporary Compound
- Temporary Turbine Component Laydown Area
- Existing Water Crossing
- Existing Water Crossing to be Upgraded
- New Water Crossing
- Existing Access Track
- Existing Access Track to be Upgraded
- Indicative Straightened Access Track
- Indicative New Access Track
- A Track Identifier
- Potential Borrow Pit Search Areas

Peat Depth (cm)

- Nil
- 1 - 50
- 51 - 150
- >150

Peat Depth Contour (cm)

- NIL
- 1-50
- 51-150
- >150

0 0.1 0.2 0.3 0.4 km

Scale 1:8,000 @ A3

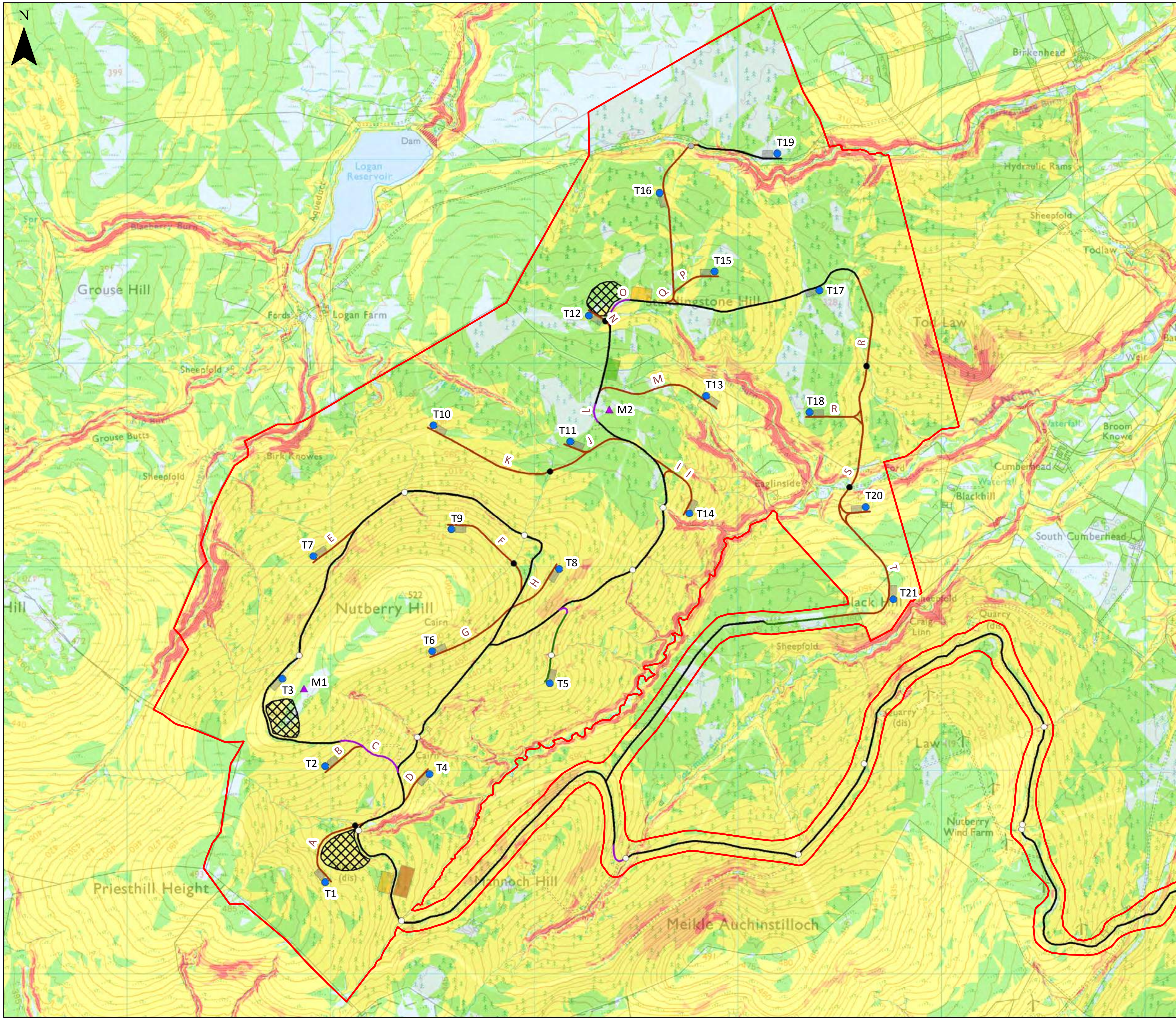
Cumberhead West Wind Farm
Environmental Impact Assessment Report

Appendix 11.1 Figure 3d

Peat Depth - East

Date:	Drawn by:	Checked by:	Version:
28/10/2020	ST	JH	V1

Project Number: 2694



KEY

- Site Boundary
- Proposed Turbine Locations
- Indicative Met Mast Location
- Proposed Turbine Laydown Area
- Proposed Substation, Control Room & Energy Storage Compound
- Proposed Temporary Compound
- Temporary Turbine Component Laydown Area
- Existing Water Crossing
- Existing Water Crossing to be Upgraded
- New Water Crossing
- Existing Access Track
- Existing Access Track to be Upgraded
- Indicative Straightened Access Track
- Indicative New Access Track
- A Track Identifier
- Potential Borrow Pit Search Areas

Slope Angle

- <=2 degrees
- 2 to 5 degrees
- 5 to 15 degrees
- 15 to 20 degrees
- >20 degrees

0 0.5 1 km

Scale 1:18,000 @ A3

Cumberhead West Wind Farm
Environmental Impact Assessment Report

Appendix 11.1 Figure 4

Slope Angle

Date:	Drawn by:	Checked by:	Version:
27/10/2020	ST	JH	V1

Project Number: 2694