Appendix 13B
Peat Landslide Risk Assessment

RWE Renewables UK Onshore Wind Ltd

Enoch Hill 2 Wind Farm

Technical Appendix 13B

Peat Landslide Risk Assessment

WSP

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Report for

Anna Eberts
Development Project Manager
RWE Renewables UK Onshore Wind Ltd
Earn House
Lamberkine Drive
Perth
PH1 1RA

Main contributors

Benjamin Amaira

Issued by

....
Richard Bagnall

Approved by

....
Graeme Smart

WSP

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Management systems

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Executive Summary

Purpose of this Report

The RWE Renewables UK Onshore Wind Ltd ('the Applicant') is submitting a planning application for the Enoch Hill 2 Wind Farm ('the Proposed Development'). This report presents the findings of a desk-based review of the relevant baseline information related to the Enoch Hill 2 Wind Farm site ('the Development Site'), related peat survey results and the Peat Landslide Risk Assessment. The information is required to support the assessment of potential environmental impacts assessed in **Chapter 13 Geology, Hydrology and Hydrogeology** of the Environmental Impact Assessment Report ('EIAR'), and the report presented here forms **Technical Appendix 13C** to that chapter.

Desk Study

The Development Site is located approximately 6km southwest of New Cumnock, within the county of East Ayrshire, Scotland, and covers an area totalling approximately 127 hectares (ha). The Development Site is situated within an irregularly shaped boundary, mainly containing commercial forestry plantation with open moorland present within the clearings between the trees.

The Development Site is situated within an area of moderately undulating topography that lies at an elevation ranging between 230m and 531m AOD. The Development Site is situated mainly on the slopes of Strandlud Hill which is the highest of the hills within or near the Development Site. The main access track runs along the mid and lower slopes of Meikle Hill, Auchincally Hill and Milray Hill. Ordnance Survey Terrain 5 data indicates that the Development Site contains slope angles ranging from 1^{o} up to 39^{o} degrees.

The Soil Map of Scotland indicates that the Development Site is predominantly underlain by blanket peat. The Development Site is also shown to contain areas of mineral gleys in the location of the substation compound and peaty podzols and peaty gleys in the northwest of the Development Site.

The NatureScot Carbon and Peatland 2016 map indicates that the soils within the Development Site are predominantly Class 5 (all soils are carbon-rich and deep peat but no peatland habitat is recorded). There are also areas of Class 0 soils (mineral soils) in the location of the substation compound and Class 3 soils (mostly carbon-rich soils with some deep peat and occasional peatland habitats) in the far northwest of the Development Site.

Geological mapping indicates that the Development Site is partially underlain by peat that extends through the central area of the Development Site to the summit of Strandlud Hill. In addition, peat is shown at Blood Moss near the substation compound and in a localised areas along the main access track. The underlying bedrock comprises formation of wacke.

Ordnance Survey mapping (2023) reveals that the Development Site is situated on the watershed between the Water of Deugh and River Nith catchments. The majority of the Development Site drains northwards to the Afton Water and the River Nith. The south of the Development Site including the location of WTG[1]-02 is drained southward to the Water of Deugh.

A review of available historical and contemporary photographic imagery of the Development Site has been undertaken. However, the available photography is in black and white and at a small scale (1:24,000) and as such it was not possible to identify historical peat slide features. A review

[1] Wind Turbine Generator

of the contemporary aerial imagery has identified salient peat slide features including a potential bog pool and commercial forestry.

Field Surveys

A programme of peat depth surveys has been undertaken by Wood Environment & Infrastructure UK Limited (now WSP) in general accordance with the Scottish Government guidance. The peat depth surveys were scoped according to the best practice guidance, however peat probing was not possible in places due to the existing commercial forestry which restricted access.

In total, peat depth surveys undertaken at the Development Site have comprised 479 peat depth measurements which have revealed depths ranging between 0.00m and 3.00m. A total of 130 (~27%) recorded peat depths ≥0.5m and the calculated mean of all peat depths ≥0.5m was 0.85m.

The peat depth data obtained during the surveys have been used to generate an interpolated peat depth map for the site which indicates that the Development Site is dominated by peat depths <0.5m across much of the Development Site including at WTG-02 and the location of the substation compound. In the central part of the Development Site areas with peat depths >0.5m but <1.0m are indicated southwest and northeast of WTG-01. In addition, localised areas with peat depth >0.5m have been identified along the main access track in seven locations. The Development Site also contains localised areas of deep peat >1.0m in thickness located to the south of WTG-01 and between WTG-01 and the substation compound. In addition, localised areas of deep peat are identified in three locations along the main access track, the largest of which is located across the valley of the Glenshalloch Burn.

During the peat surveys, the presence of geomorphological features were generally limited in number, only comprising a bog pool to the northeast of the Strandlud Hill summit. No relic or insipient failure features have been identified within the Development Site.

Peat Landslide Risk Assessment

An assessment of peat landslide risk has been undertaken in general accordance with the Scottish Government best practice guide. The likelihood of peat instability occurring has been determined from a review of the contributing hazard factors (including slope angle, peat depth, slope curvature, natural drainage, artificial drainage, pre-failure indicators, forestry and geology). In addition, a semi-quantitative peat slope stability assessment has been undertaken using the ‘Infinite Slope’ method to support the likelihood assessment.

The results of the peat landslide likelihood assessment indicate that there are no parts of the Proposed Development’s layout within an area of Almost Certain likelihood. The likelihood of a peat slide at the Proposed Development is generally considered to be Negligible to Likely with the majority of the Proposed Development within areas of Negligible likelihood. An area of Almost Certain likelihood has been identified downslope to the east of the section of the access track running between WTG-01 and WTG-02 in the Carcow Hass area of the Development Site.

The results of the peat landslide risk assessment indicate that the Development Site is considered to be at a Negligible to Low risk of peat landslide failure. An area of Moderate risk is identified adjacent to the west of the track between WTG-01 and WTG-02 in the Carcow Hass area of the Development Site. This is likely to be a result of the higher peat landslide susceptibility based on the infinite slope analysis under the loaded scenario which assumed loading the entire Development Site with an additional 1.0m of peat. However, given that no development is proposed in this area of the Development Site the risk of failure is considered to be low.

Recommendations

A post-consent detailed ground investigation is recommended to assist in detailed assessment of peat slope stability in the most sensitive areas of the Proposed Development. The ground investigation should also aim to establish the nature and geotechnical parameters of the peat and peat substrate interface. It is recommended that ground investigation information is used to check / verify the peat slope stability assessments. Where access to the proposed location of infrastructure was not possible during the peat survey due to the access constraints relating to forestry presence, additional probing in these areas is recommended to confirm the modelled peat depths and peat landslide risk assessment.

The assessment indicates that the Development Site is largely at a Negligible to Low risk of peat landslide failure and, while there is an area of Moderate risk located to the east of the track between WTG-01 and WTG-02 in the Carcow Hass area; however, the likelihood of failure is considered unlikely and the risk therefore low as no development is proposed in this area. Should the detailed pre-construction ground investigations identify features that may increase the susceptibility of peat to slide (e.g. peat pipes and flushes), the primary mitigation to be employed will be use of the micro-siting allowance (50m). Where necessary to further reduce risk, the Proposed Development layout would be refined within the micro-siting allowance to locate infrastructure in areas of the shallowest peat or peaty soils.

The other mitigation measures employed would be to minimise additional loading of susceptible peat covered slopes, maintain the current drainage of the peat, avoid ponding of surface water and where necessary redirect drainage to a purpose-built network. In addition, monitoring of slopes may be required where a detailed ground investigation of the proposed infrastructure confirms that sensitive slopes may be moderately susceptible to peat landslides.

In conjunction with the above, a geotechnical risk register should be developed and maintained by a geotechnical engineer throughout the life cycle of the Proposed Development. During construction, a Geotechnical Clerk of Works should also be present on site to monitor sensitive slopes for movement and to manage any changes to the peat landslide risks.

Contents

1. Introduction

1.1 Background

WSP was commissioned by RWE Renewables UK Onshore Wind Ltd ('the Applicant') to undertake a Peat Landslide Risk Assessment for the proposed Enoch Hill 2 Wind Farm, comprising two wind turbine generators, battery storage facility and associated supporting infrastructure. The 'Proposed Development' is located in East Ayrshire approximately 6km to the south-west of New Cumnock and approximately 9km east of Dalmellington, just to the north of the border with Dumfries and Galloway. It is centred at coordinates easting (E)258250, northing (N)606680. The 'Development Site' (shown in **Figure 1.0 - Appendix A**) covers an area totalling approximately 127 hectares (ha).

An initial review of desk-based information indicated that the Development Site contains blanket peat and peaty soils as well as slopes angles greater than 2 degrees. As such, in accordance with Scottish Government best practice guidance[2] (the best practice guide) a Peat Landslide Risk Assessment ('PLRA') is required to support the Environmental Impact Assessment ('EIA') and Planning Application for the Proposed Development.

This PLRA supports the impact assessments conducted in Chapter 13 of the EIA Report and has been prepared from the information sources identified and described in Section 1.5 as well as site surveys.

1.2 Scope and Purpose of Report

The purpose of this report is to present the findings of a desk-based review of site information, peat survey results and a PLRA that has been conducted in accordance with the Scottish Government best practice guide. The peat landslide risk assessment comprises the following scope of work:

- a review of desk-based information including geological, soil, hydrological and hydrogeological data;
- a description of the findings and results of site reconnaissance and peat depth surveys;
- identification of salient geomorphological features related to processes of peat erosion, drainage and mass movement;
- identification and assessment of potential peat landslide hazards;
- preliminary quantitative slope stability assessment by infinite slope analysis using geotechnical parameters derived from literature sources; and,
- peat landslide risk assessment using the principles set out in the best practice guide.

1.3 Proposed Development

The Proposed Development comprises the following infrastructure:

- Two wind turbine generators ('WTG');
- Primary and auxiliary crane pads at each wind turbine generator;

[2] Scottish Government (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments

- Blade laydown areas at each wind turbine generator;
- Control building and substation compound;
- Temporary construction compound;
- Battery storage compound; and
- Approximately 2km of new on-site access track and the upgrade of approximately 6km of existing access track.

The Proposed Development layout is presented in **Figure 2.0** in **Appendix A**.

1.4 Assessment Methodology

The assessment methodology uses a qualitative assessment of the peat slide hazards supported by field observations and a deterministic approach supported by field observations and published literature. The preliminary risk assessment is based on the following approach:

- a desk-based review of site information;
- Phase 1 peat depth survey and site reconnaissance of the developable area;
- Phase 2 peat depth survey of the Proposed Development layout;
- identification of the hazards and consequences;
- preliminary slope stability analysis based on literature sources; and,
- peat landslide risk assessment.

The risk assessment uses the results of the qualitative and deterministic approaches to allocate levels of peat landslide risk for peat slides and bog flows spatially across the Development Site in accordance with best practice guidance.

1.5 Sources of Information

The sources of desk-based information reviewed as part of these works are summarised below. In addition, literature sources of information have been referenced in in the Bibliography section. The following sources of information have been reviewed:

- Ordnance Survey ('OS') mapping;
- British Geological Survey ('BGS') digital and published geological mapping;
- Scottish Government, Soil Map of Scotland digital mapping;
- Scottish Environment Protection Agency ('SEPA') website;
- NatureScot website;
- Contemporary and historical aerial photography;
- Digital Terrain Models ('DTM');
- East Ayrshire Council Private Water Supply data;
- Enoch Hill Wind Farm, Peatslide Hazard and Risk Assessment, Amec Foster Wheeler, October 2016; and,
- Enoch Hill Wind Farm, Discharge of Condition 17 – Peat Landslide Risk Assessment, Wood, March 2022.

1.6 Project Team

The field surveys were led by the author (Benjamin Amaira) and issuer (Richard Bagnall) of this peat landslide risk assessment, accompanied by a team of surveyors that included geotechnical engineers and geo-environmental engineers. The experience of the peat surveying team ranged from 1 year post graduate experience to more than 12 years-experience and surveys of multiple sites with complex geomorphology.

The peat landslide risk assessment has been carried out and reviewed by geo-environmental and geotechnical engineers with significant experience of undertaking peat landslide risk assessments on sites across Scotland. Details of their experience are provided in **Appendix B**.

1.7 Assumptions and Limitations

The following assumptions and limitations apply to the contents of this peat landslide risk assessment:

- This assessment has been prepared and written in the context of the Proposed Development layout, guidance, and literature sources available at the time of writing. New information, improved practices and changes in guidance or significant alterations to the layout may necessitate a re-interpretation of the assessment in whole or in part after its original submission.
- It should be recognised that the peat surveys and interpolations based on the site surveys undertaken to date provide information characterising the variation of peat depths and that different conditions may be present between survey locations.
- No ground investigation or samples of peat have been obtained for geotechnical testing during field surveys. Where observations relating to the peat substrate are presented these relate solely to the conditions at the exposure location and it should be recognised that different conditions may be present in other parts of the Development Site.
- Access constraints were encountered during the surveys that are detailed in **Section 4.1**.

2. Peat Instability

Peat is an organic material formed by the accumulation of plant matter at various stages of decomposition, formed over many thousands of years. The characteristics of peat vary widely depending on, but not limited to, the nature of plant material that the peat is derived from, the degree of decomposition and the type of peat bog. A peat landslide represents the most extreme and rapid process by which peat bogs are degraded and pose a risk to the Proposed Development and neighbouring environmental and human receptors.

In Scotland, the Scottish Government defines peat and deep peat as follows (Scottish Government, 2017):

- Peaty soils: soils with an organic horizon <0.5m thick;
- Peat: soils with an organic surface horizon greater than 0.5m in thickness and an organic matter content exceeding 60%; and
- Deep peat: a peat as defined above, with a depth greater than 1.0m.

There are two distinct types of peat, termed acrotelmic and catotelmic peat. The interface between the two layers is controlled by the position of the water-table. The upper layer of the peat (the acrotelm) is typically fibrous and comprises the living and partially decomposed peat forming plant matter. The thickness of the acrotelm is typically controlled by seasonal variations in the water-table that creates cycles of aerobic and anaerobic conditions near the surface. The catotelm is situated below the minimum average depth of the water-table (Evans and Warburton, 2010). This results in permanent anaerobic decomposition of the plant matter and the formation of less fibrous amorphous peat.

The term 'peat landslide' is a broad term referring to two major groups of peat slope mass movement (or failure); 'bog burst' and 'peat slides'. Dykes and Warburton (2007) developed a classification scheme for mass movements of peat to define the terminology used to describe the types of peat slope failure. The following forms of peat mass movements have been defined by Dykes and Warburton (2007):

- Bog bursts and bog flows – failure by breakout of liquid catotelmic peat differentiated by the type of bog (raised bogs or blanket bogs respectively);
- Peat slides and bog slides – translational sliding of intact peat along a failure surface, differentiated by the failure plane being at the base or within the peat, respectively;
- Peaty-debris slides – translational failure of a slope covered with blanket peat where the failure occurs beneath the peat-substrate interface; and
- Peat flows – failure of any other peat bog type (e.g. fen peat).

Dykes and Warburton (2007) and Evans and Warburton (2010) indicate that bog bursts and flows are characteristic of deep peat with depths typically in the range of 1.5m to 6.5m situated on shallow slopes in the range of 2 to 8 degrees. Peat slides and bog slides have typically been reported on steeper slopes in the range of 5 to 15 degrees but in shallower thicknesses of peat in the range of 1m to 3m in thickness. However, as described in Evans and Warburton (2010) a limited number of bursts and slides have been reported outside of these ranges.

A peat landslide is the result of the combination of preparatory factors and trigger factors that either reduce the shear strength of the peat or increase the shear stress on the peat covered slope (Evans and Warburton, 2010). These factors directly or indirectly relate to changes in the hydrology of the peat that can occur rapidly or over a long period of time, and that include natural and anthropogenic (man-made) factors such as (Scottish Government, 2017):

- Increases in the mass situated on the slope (e.g. peat accumulation, seasonal water-table variations and the mass of planted trees);
- Reduction in shear strength through changes in the peat or substrate (e.g. drying and desiccation cracking);
- Loss of surface vegetation (e.g. burning);
- Increased buoyancy through impeded drainage, pooling, pipe networks and rapid rewetting of desiccation cracks; and,
- Commercial afforestation of peat resulting in lowering of the water-table and deep desiccation cracking.

In addition, Evans and Warburton (2010) indicate there are a number of pre-conditions that predispose a slope to failure that relate to the hydrological processes within the peat. These include:

- Impedance of drainage below the peat caused by impermeable clays or iron pans in the substrate;
- A convex slope or break in slope that can concentrate flows;
- Proximity to drainage features such as flushes, peat pipes and streams; and,
- Connectivity between the surface drainage and an impervious peat-substrate interface.

Where the combination of preparatory and pre-failure conditions occur, a peat landslide may be triggered on susceptible slopes by a number of possible trigger factors. The trigger factors can be natural or anthropogenic and are typically related to those that rapidly cause changes in the pore-water pressure, reduce shear strength or rapidly increase the mass on the slope. These factors include:

- Intense rainfall or snow melt and rapid migration to the peat-substrate interface;
- Ground accelerations due to earthquakes, vibrations from vehicles and blasting;
- Incision of the peat slope by streams and rivers, peat turve cutting and excavations during construction causing a rapid reduction in support at the toe of the slope;
- Rapid loading of the peat by landslide debris sliding onto susceptible peat slopes;
- Loading of the peat by heavy plant, digging and tipping; and,
- Alteration of natural drainage routes resulting in focussed drainage on susceptible slopes.

3. Site Setting

3.1 Site Location and Description

The Development Site is located approximately 6km southwest of New Cumnock within the county of East Ayrshire, Scotland. The Development Site is located at approximate central Ordnance Survey National Grid reference 258250E, 606680N and covers an area totalling approximately 127 hectares (ha). The 'main' part of the Development Site in the west where turbines, battery storage and other wind farm infrastructure would be located is linked to Afton Road to the east via an existing access track that runs through Pencloe Forest.

The location and layout of the Proposed Development are presented as **Figures 1.0** and **2.0** in **Appendix A**, respectively.

The main access to the Proposed Development is at Pencloe Farm, located in Glen Afton, approximately 4km northeast of the main part of the Development Site. The existing access track (the main access) runs southwards through enclosed rough pasture, before accessing the forestry to the west of the Lochingerroch Burn and leading up to the main part of the Development Site. The Proposed Development is located at the south-western end of a ridge of hills that run from Ashmark Hill located offsite to the northeast to Strandlud Hill located within the Development Site.

The land use within the Development Site is entirely commercial forestry with openings in the trees at the summit of Strandlud Hill and along rides and clearings between the stands.

3.2 Published Geology

Pedology

The 1:25,000 Soil Map of Scotland (The James Hutton Institute, 2020) indicates that the Development Site is predominantly underlain by blanket peat that is present in the proposed location of both turbines and their associated infrastructure. The Development Site is also shown to contain areas of mineral gleys in the location of the control building and substation compound, temporary construction compound and battery storage compound. In addition, the Development Site contains areas of peaty podzols and peaty gleys the northwest of the Development Site away from the Proposed Development. The 1:25,000 Soil Map of Scotland is presented as **Figure 3.0** in **Appendix A**.

The NatureScot Carbon and Peatland 2016 map (NatureScot, 2016) is presented as **Figure 4.0** in **Appendix A**. The map indicates that the soils within the Development Site are predominantly Class 5 at the proposed location of both turbines, their associated infrastructure and along the main access track. These are areas where soil information takes precedence over vegetation data and where no peatland habitat is recorded. Class 5 soils are carbon-rich and deep peat. The Development Site also contains an area of Class 0 (mineral soils) soils in the location of the control building and substation compound, temporary construction compound and battery storage compound. The Development Site also contains an area of Class 3 soils in the far northwest portion away from the proposed infrastructure. These are areas where occasional peatland habitats can be found and most soils are carbon-rich, with some areas of deep peat.

Superficial Deposits

British Geological Survey ('BGS') mapping indicates that the Development Site is partially underlain by peat and that it underlies the location of WTG-01. The peat is shown to extend through the central area of the Development Site along the ridge line from Ewe Hill to the summit of Strandlud Hill in a northeast to southwest direction. In addition, peat is shown at Blood Moss within and adjacent to the east of the control building and substation compound and in a localised area along the main access track, including on the lower north facing slopes of Auchincally Hill.

The remainder of the Development Site, including parts of the Proposed Development layout (such as the majority of the control building and substation compound, temporary construction compound, battery storage compound and the location of WTG-02) are shown to be underlain by Glacial Till and thin or absent deposits. The proposed main access track is shown to cross an area of Alluvium at the Glenshalloch Burn.

The BGS digital geology map of superficial deposits is presented as **Figure 5.0** in **Appendix A**.

Solid Geology

British Geological Survey mapping indicates that the Development Site is underlain by the Leadhills Supergroup, comprising wacke and mudstone. The main access track is underlain by the Kirkcolm Formation, comprising wacke.

The Development Site is shown to be underlain by four geological faults. In the centre of the main access track, a fault is shown striking northwest to southeast on the west side of Meikle Hill. The second and third faults are parallel to the first with one crossing the main access track approximately 165m east of the substation compound and the other approximately 90m southwest of WTG-02. The fourth geological fault is a reserve thrust fault striking generally northeast to southwest along the Carcow Burn and through the far northwest of the Development Site.

The BGS digital geology map of bedrock is presented as **Figure 5.0** in **Appendix A**.

3.3 Topography

The OS Terrain 5 Digital Terrain Model ('DTM') reveals that the Development Site lies at an elevation ranging between approximately 230m and 531m Above Ordnance Datum ('AOD'). The layout of the Proposed Development (including the turbines and associated infrastructure) lies at an elevation ranging between approximately 385m and 510m AOD. The ground elevations along the main access track are shown to be between 229m and 467m AOD.

The Development Site is situated within an area of moderately undulating topography, containing a number of promontories located to the north and south of the Development Site, which are separated by typically narrow steep sided valleys. The turbines and associated infrastructure of the Proposed Development are situated on Strandlud Hill which is the highest of the hills within or near the Development Site and which forms a slight saddle between it and an unnamed minor summit to the northwest of WTG-01. The main access track passes along the mid and lower slopes of the thills to the south of the Development Site including Meikle Hill, Auchincally Hill and Milray Hill.

The OS DTM has been used to generate a slope angle raster in ESRI ArcGIS. This analysis indicates that the Development Site contains slope angles ranging from 1^{o} up 39^{o} degrees. The proposed main access track is shown to pass through areas with slope angles that range from $<1^{o}$ degrees to 38^{o} degrees.

The OS Terrain 5 slope angle analysis is presented as **Figure 6.0** in **Appendix A**.

3.4 Hydrology

OS mapping reveals that the Development Site is situated on the watershed between the Water of Deugh and River Nith catchments. The majority of the Development Site north of Strandlud Hill and the main access track are drained northwards by a number of watercourses flowing into the Afton Water and into the River Nith, located approximately 3.9km and 6.8km northeast and north of the Development Site, respectively. The watercourses draining the Development Site to the Afton Water join it downstream of the Afton Reservoir. The south of the Development Site including the location of WTG-02 is drained southward to the Water of Deugh that is approximately 460m south of WTG-02.

The watercourses that drain the Development Site are as follows:

- Carcow Burn and minor tributaries – located to the approximately 50m southeast of the temporary construction compound and draining the Blood Moss area.
- Glenhastel Burn – located approximately 200m east of the temporary construction compound between Auchincally Hill and Milray Hill. The watercourse drains the western end of the main access track and flows northwest passing under the main access track approximately 305m southeast of the temporary construction compound before feeding into Carcow Burn and the Afton Water.
- Small Burn – located approximately 250m northwest of WTG-01 and forming part of the Development Site boundary. This watercourse drains the north-western slope of Strandlud Hill and flows down to join the Connel Burn approximately 1.3km north of WTG-01.
- Connel Burn – located at the far north-western Development Site boundary. The watercourse drains the far northwest of the Development Site beyond the minor summit to the northwest of Strandlud Hill. The Connel Burn flows northeast to join the River Nith at New Cumnock approximately 7.0km north of the Development Site.
- Auchincally Burn – located to the north of the main access track approximately 920m northeast of the temporary construction compound. The watercourse drains the north slopes of Auchincally Hill and the section of main access track running around the hill.
- Glenshalloch Burn – – located along the main access track approximately 1.60km northeast of the temporary construction compound. The watercourse flows between Auchincally Hill and Meikle Hill and flows in a northward direction to join the Connel Burn.
- Lochingerroch Burn – located approximately 180m east of the access track near Pencloe Farm and flowing northward into the Afton water.
- Bitch Burn and minor tributaries – located approximately 460m southwest of WTG-02 this watercourse drains the south-western slopes of Strandlud Hill including the location of WTG-02.
- Water of Deugh – located approximately 460m south of WTG-02 this watercourse drains the southern slopes of Strandlud Hill including the location of WTG-02.

The locations of these watercourses and waterbodies are illustrated in **Figure 2.0** presented in **Appendix A**.

The SEPA Water Environment Hub indicates that the nearest Water Framework Directive watercourse are as follows:

- Afton Water – approximately 4.0km northeast of the Proposed Development and receiving water from the Development Site via its minor tributaries. This watercourse was last classified as having a Good overall condition in 2014.

- Water of Deugh – approximately 460m south of WTG-02. This watercourse was last classified as having an overall Poor condition in 2014.

The WTG-01, control building, construction compound and the main access track of the Proposed Development are located within a Drinking Protected Area for surface water.

3.5 Hydrogeology

The Scotland's Environment map indicates that the Development Site is underlain by a low productivity aquifer, where groundwater flow is through fractures and other discontinuities.

The SEPA Water Environment Hub indicates that the Development Site is underlain by two different groundwater bodies. The majority of the Development Site north of Strandlud Hill is underlain by the Upper Nithsdale groundwater body which has been classified as having a Poor overall status by SEPA. Strandlud Hill and parts of the Development Site to the south are underlain by the Galloway groundwater body which has been classified as having an overall status of Good.

The Proposed Development is shown to be within Drinking Water Protected Area for groundwater.

3.6 Private Water Supplies

Private Water Supply (PWS) information has been provided by East Ayrshire Council and Dumfries and Galloway Councils. The information provided identifies the four private water supplies ('PWS') for domestic use within 2km of the Development Site. These are as summarised below:

- Lochbrowan, approximately 200m east of the Development Site entrance;
- Blackcraig Farm, approximately 2km southeast of the Development Site;
- Dalhanna Farm, approximately 1km north of the Development Site; and
- Laglaff Farm, approximately 1.7km northwest of the Development Site.

There are no known PWS that have the potential to be affected by a peat landslide given their recorded positions and topographic barriers between them and potential source areas.

The nearest PWS's to the Development Site are shown on **Figure 14.0** in **Appendix A**.

3.7 Designated Sites

The NatureScot SiteLink map has been consulted for information on protected sites. The map reveals that the Development Site is not located within or near any designated ecological protection area (e.g. Ramsar sites, sites of special scientific interest).

An assessment of the site for potential Groundwater Dependent Terrestrial Ecosystems ('GWDTEs') has been performed in Chapter 13 of the Environmental Impact Assessment. A National Vegetation Classification ('NVC') survey undertaken on the Development Site in 2016 indicated the presence of species that potentially have some groundwater dependency. These were identified at the higher elevations of the Development Site predominantly in areas along forestry-cleared areas for firebreaks, tracks and drainage, as well as along the Connel Burn valley in the west of the Development Site. Further assessment of the potential GWDTEs indicates that there are no truly groundwater-dependent habitats present, or groundwater dependency is low.

3.8 Landslide Inventory

The BGS GeoIndex reveals that there are no recorded landslides or peat landslides within the vicinity of the Development Site.

3.9 Historical Mapping

A review of the available online historical mapping provided by the National Library of Scotland Map Images website[3] has been undertaken to establish the historical land use and identify any features that may indicate a historical peat landslide. The historical mapping date 1850 to 1964 indicates that there are no recorded place or feature names that are likely to relate to a historical peat slide. In addition, there have been no obvious major changes to the course of any surface watercourses draining or near the Development Site which would potentially indicate that a peat slide had occurred. The only feature of relevance is the pool on Strandlud Hill and the presence of Blood Moss that are also present on contemporary OS mapping.

The historical land use of the Development Site is characterised by open moorland until sometime between 1964 and the present when the current forestry land use is established.

3.10 Imagery and Photography

Historical Imagery

An online search of the National Collection of Aerial Photography ('NCAP') has been undertaken to identify any indications of historical peat landslides. However, the available photography is in black and white and at a small scale (1:24,000) and as such it was not possible to identify historical peat slide features.

Contemporary Imagery

A 25cm resolution aerial image of the Development Site (excluding the main access) captured in 2010 has been obtained and is presented as **Figure 7.0** in **Appendix A**. A review of the aerial image reveals the following salient peat slide features within the Development Site boundary:

- A potential bog pool is identified approximately 245m southeast of WTG-01 at National Grid reference 258291, 606214 (see **Figure 10.0** and the photographs in **Appendix C**);
- Numerous commercial forestry stands throughout the Development Site with tree planted in rows in various orientations.

The review of the aerial imagery reveals that there are no identifiable relic peat slide or other peat drainage or mass movement features apparent within the Development Site. However, it should be recognised that imagery of the ground is obscured for a significant proportion of the Development Site due to the tree canopy and the shadows cast by the trees.

Google Earth (© 2020 Google, imagery date 2018) aerial imagery has also been reviewed for indications of peat slide features in the wider area of the Development Site. However, the land to the south, east and west of the Development Site is obscured by commercial forestry and where the ground is visible a significant proportion of it has been disturbed by forestry furrows. Where the ground is visible and undisturbed no obvious peat slides have been identified. To the north of the Development Site is an area of open moorland. A review of the aerial imagery along the ridge on

[3] Map images - National Library of Scotland (nls.uk)

which the Development Site is situated reveals that the moorland has been heavily gripped but there are no obvious peat slides.

Public Photography

An online search of the Geograph Project Limited website (https://www.geograph.org.uk/) has been performed to identify images of the Development Site. The Development Site contains numerous images providing information on the topography and geomorphology. However, none of the images provide additional information on the Development Site topography or geomorphology.

3.11 Previous Investigations

In 2013 Wood E&I UK Limited (now WSP) were commissioned by E.ON Climate and Renewables UK Developments Ltd ('E.ON') (now RWE), to provide a peat slide risk assessment on the now consented Enoch Hill Wind Farm that is located adjacent to the north of the Development Site and centred on National Grid reference 257360, 608630. The consented Enoch Hill Wind Farm site shares similar underlying geology, historical land use, topography and climate to the Development Site, therefore the surveys and assessment provide useful information on the local peat depths and the presence of geomorphological features.

A number of peat survey campaigns were undertaken across the Enoch Hill Wind Farm (pre and post consent) that totalled 2,292 peat depth measurements. These were undertaken in 2012, 2014/2016, 2018, 2020 and in 2021. The peat depths ranged between 0.0m and 3.30m with a total of 1,345 (58%) recording peat depths ≥0.5m. The calculated mean of peat depths ≥0.5m was 1.02m and the most frequently recorded peat depth at the Development Site was 0.5m.

During the peat surveys, geomorphological features were identified, typically in areas of deeper peat with depths exceeding 1.0m in thickness. The most numerous features identified were man-made peat grips and drainage ditches. Whilst features associated with natural drainage and erosion processes were identified, these were limited in number and typically comprised one area of hagging and flushes. In addition, a peat pipe and a potential pipe collapse were identified on the Polga Burn.

The only indication of a relic peatslide feature was a possible slide encountered on the north face of Enoch Hill. The possible slide comprised an area of slumped peat on the moderately steep slope with a visible backscar and a peat grip at the toe of the slide. Further potential slope movement by slope creep was identified on the south side of Enoch Hill where possible tension cracks and micro terracing of the slope was identified in an area where peat depths ranged from <0.5m to >2m in thickness.

Along the steep side slopes of the Littlechang Burn, Catlock Burn, Knockburnie Burn, Crocradie Burn and the Trough Burn numerous translational slides of the mineral soils and weathering materials were identified. These features generally accord with the aerial photography and typically comprise an arcuate scar on the valley side with rafts of topsoil and exposed superficial deposits and/or bedrock.

An assessment of the peat landslide risk was undertaken in general accordance with Scottish Government best practice guide. The assessment of six contributory hazards factors adjusted by infinite slope analysis was undertaken and combined with the consequences of a failure. The results of the peat landslide risk assessment indicated that the consented Enoch Hill Wind Farm site was considered to have a Negligible to Moderate Risk of peat landslide failure. However, no areas of the proposed layout were recorded as having a High Risk of peat instability.

4. Field Surveys

4.1 Peat Depth

Methodology

A programme of peat depth surveys has been undertaken at the Development Site, over two phases in general accordance with the Scottish Government document on 'Guidance on Developments on Peatlands: Site Survey (2017)' as set out below. Survey methodology was adapted where required to account for the on-site constraints set out in the 'Survey Constraints' section below.

Phase 1 Survey

A Phase 1 peat depth survey was undertaken by WSP to characterise peat depths within the Development Site between the 25th and 26th May 2017. The survey was undertaken on a 100m x 100m grid during a period dry and sunny weather with moderate winds.

Phase 2 Survey

The Phase 1 survey was followed by a detailed Phase 2 peat depth survey undertaken by WSP on the 25th and 26th November 2019 during a during a period of wet and cold weather with light winds preceded by similar conditions. The survey specifically targeted the layout of the Proposed Development.

The scope of the Phase 2 survey was developed in general accordance with the Scottish Government guidance document on peat surveys as follows:

- 1 no. probe was placed at 50m intervals along new access tracks plus 1 no. probe placed 10m perpendicular to either side of the track;
- 1 no. probe was placed up to 10m either side of existing access tracks that will be upgraded for the Proposed Development;
- probes were placed on a 25m grid at the proposed turbine locations covering a 50m circular micro-siting area;
- probes were placed on a 10m grid at other elements of the Proposed Development such as the temporary construction compound and control building and substation compound.

The peat depth surveys were undertaken using extendable peat utility probes driven into the ground until refusal. The results at each survey location were recorded using a hand-held GPS device with data entered into GIS.

Supplementary Phase 2

In March 2023 WSP was commissioned by RWE to undertake a supplementary peat depth survey on the updated layout of the Proposed Development. The survey was undertaken on 28th February 2023 during a period of light rain and snow.

The supplementary Phase 2 survey comprised the following scope:

- 1 no. probe at 50m intervals along all access tracks;
- 1 no. probe 10m perpendicular to each side of the track only where peat depths are >0.5m;
- a star of transects at 10m intervals covering the micro-siting buffer;
- a 15m grid of points at the control building and substation compound, temporary construction compound and battery storage compound location. .

The above scope was altered as necessary to increase or decrease the density of peat depth measurements based on the depths encountered at each location as the supplementary Phase 2 survey progressed. Where peat depths were found to be <0.5m the intervals were increased.

Survey Constraints

Access constraints were encountered during the peat probing survey, due to the presence of dense and juvenile trees, as well as windblown trees. Where constrained, peat probing was undertaken as close as possible to the Proposed Development along suitable access routes including rides, clearings, plantation lines, watercourses and suitable openings along forestry drainage ditches.

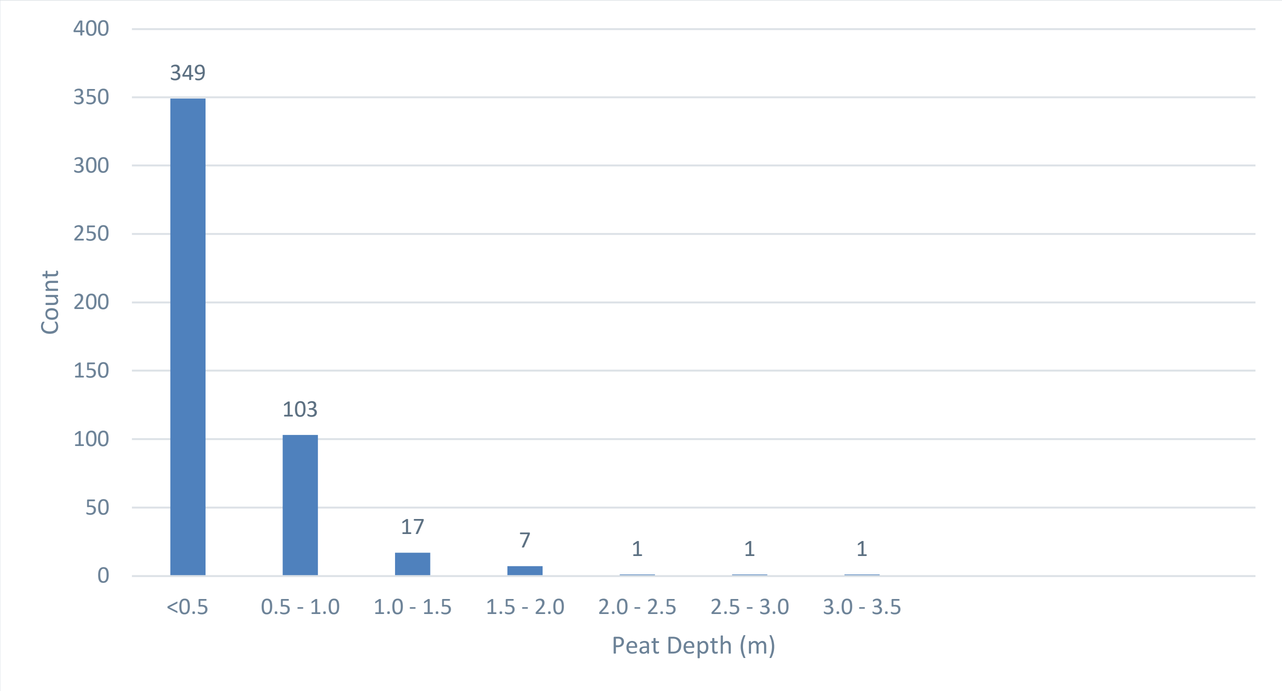
During the Phase 2 survey it was noted that the main access track had been substantially upgraded between the start of the forestry near Pencloe to a quarry to the west of Auchincally Hill (at grid reference 259790, 606771). The construction of the upgraded track has resulted in a significant amount of ground disturbance either side of it, resulting in substrate materials (e.g. gravels, cobbles and boulders) being mixed with the organic soil horizons (which include peat). This led to difficulty in surveying this section of the main access track and therefore only a limited number of points were surveyed.

Mineral soils were visually identified along the length of the proposed main access track in the fields between the public highway at Pencloe and the beginning of the forestry. Therefore, no additional probing was undertaken on this section of the track.

Peat Depth

In total the peat depth surveys undertaken across the Development Site have comprised 479 peat depth measurements, which has revealed peat depths ranging between 0.00m and 3.00m. A total of 130 (~27%) survey locations have recorded peat depths ≥0.5m and the calculated mean of all peat depths ≥0.5m is 0.85m. Figure 4.1 below summarises the distribution of peat depth measurements recorded within the Development Site and peat depth data is included in **Appendix D**.

Figure 4.1 Summary of all peat depth data



A composite plan of all peat depth data is presented in **Figures 8.0 to 8.5** in **Appendix A**.

The peat depth data obtained during the surveys has been used to generate an interpolated peat depth map for the Development Site. This has been achieved by using ESRI ArcGIS and the Natural Neighbour interpolation method. This method was chosen given the relative simplicity of the weighting compared to other interpolation methods. It also avoids exaggeration of minimal and maximal values and results in a modelled surface that passes through the sample point value. The method also does not produce a pronounced "bulls-eye" effect on the modelled surface. However, unlike other methods it is not possible to barrier the interpolation. It also models depths over the furthest geographic extent and does not extrapolate out from the maximum extents of the sample points to the maximum rectangular extent. This method also calculates cell values across the longest extents of the sample points resulting in interpolations over large distances where there are gaps in the sampling points or they are irregularly distributed.

Figure 9.0 in **Appendix A** shows the interpolated peat depths across the Development Site.

The interpolated peat depth map indicates that the Development Site is dominated by peat depths <0.5m across much of the southwest, centre and north, including at the WTG-02 location and at the location of the temporary construction compound. In the central part of the Development Site, there are areas with peat depths >0.5m but <1.0m, located between approximately 275m southwest of WTG-01 and approximately 560m to the northeast. In addition, localised areas with peat depth >0.5m have been identified along the main access track in seven locations. The Development Site also contains localised areas of deep peat >1.0m, in thickness located approximately 75m and 160m south of WTG-01 and approximately 35m north of the access track between WTG-01 and the temporary construction compound. In addition, localised areas of deep peat are identified in three locations along the main access track, the largest of which is located across the valley of the Glenshalloch Burn.

4.2 Peat Characteristics

During the Phase 2 survey a total of 5 no. Russian core samples were inspected which revealed that the peat had a typical two layer peat profile. In general, moisture content values were found to be low (i.e. von Post class B2) and humification values were typically between H4 and H7 with values generally of H6 to H9 in the deeper layers of peat. Based on the modified von Post classification scheme (Hobb, 1986) the following characterisation of the peat profile applies:

- Upper layer (0.1 – 0.3m thick) – H7 B2 F2 R2 W0 A1 P0
- Lower layer (0.4 – 1.5m thick) – H9 B2 F2 R2 W0 A2 P1

It should be noted that the above is a general characterisation of the peat layers and as such localised variations should be anticipated across the Development Site.

4.3 Peat Substrate

Where exposed, predominantly by cuttings for existing tracks, the underlying substrate was noted to comprise wacke bedrock of sandstone.

No substrate was extracted in the Russian core samples.

4.1 Laboratory & In-situ Testing

Due to the inherent material variability, the difficulty in obtaining representative samples of peat and thus obtaining sensible and reproducible geotechnical parameters, samples were not recovered during this investigation. The collection of samples is not considered critical for the purpose of this assessment. While in-situ hand shear vane testing is commonly used to establish the undrained strength of peat, the interpretation of hand vane results is complicated by the presence of fibres and the ease of deformation of the peat during the test (Boylan et al, 2008).

4.2 Geomorphology

A geomorphological study of the Development Site was attempted during the peat surveys. However, due to the afforested nature of the Development Site, the study was limited to areas of open ground only.

The bog pool identified by the review of aerial imagery and Ordnance Survey mapping was the only significant feature identified during the surveys. In addition, minor features were noted associated with natural drainage processes. These typically comprised localised flushes identified by a change in vegetation type at surface level along with the presence of saturated ground.

No peat pipes, relic or incipient failure features were identified within the Development Site.

The location of the features identified are presented in **Figure 10.0** in **Appendix A**.

5. Peat Landslide Hazard Assessment

5.1 Background

The following assessment of peat stability has been undertaken, in general accordance with the Scottish Government best practice guide. This method considers the likelihood (i.e. the susceptibility) of a peat landslide associated with a particular area of peat multiplied by the consequences of a failure, to derive the potential risk. This is expressed as:

Risk = Likelihood x Consequence

The assessment of the peat landslide likelihood has been undertaken for peat slide failure types as defined by the Dykes and Warburton (2006) formal classification scheme. An assessment of the susceptibility of the Development Site to bog flow failure has not been undertaken due to the general absence of slope and peat depth conditions that are characteristic of bog flow failure (e.g. very deep peat and shallow slopes).

The assessment of likelihood has been undertaken through the identification, assessment and mapping of contributory hazard factors for peat slide failure types supported by a semi-quantitative assessment of peat slide susceptibility using the infinite slope model.

The assessment of peat slide hazards involves the allocation of hazard rating values for the various contributory and pre-condition factors that influence the probability of a peat slide based on the findings of literature research. However, current guidance does not define the hazards that should be assessed nor the ratings that should be applied. In addition, there is no published guide specifically relating to this issue. As such, it is left to the judgement of the assessor to develop their own approach to the assessment of the hazards. A review of literature sources (see Section 5.2) has indicated that the likelihood of a peat slide occurring is a combination of following contributing and pre-condition hazard factors:

- Slope angle;
- Peat depth;
- Slope Curvature;
- Natural Drainage;
- Artificial Drainage;
- Pre-failure Indicators;
- Forestry; and,
- Geology.

The hazards posed by each contributory factor have been individually scored based on their specific relevance to peat instability using both site observations and desk top studies. The hazard assessment relates the importance of the hazard to a scale of 1 to 5 as summarised in **Table 5.1** below.

Table 5.1 Hazard Scoring

Scale	Description
5	Extremely Serious
4	Serious
3	Substantial
2	Significant
1	Insignificant

A hazard ranking has then been calculated by the combination of each contributing factor thus allowing for the determination of the likelihood of instability as described in Section 6. The scores for each hazard factor are presented in the following sections and summarised in **Figure 11.0** in **Appendix A**.

5.2 Hazard Assessment

The following sections provide discussion on the contributory hazard factors and the method for assessing and scoring the hazards.

Slope Angle

The OS Terrain 5m DTM has been used to assess the slope angles across the Development Site.

Hazard scores have been based on information contained within published literature relating to historical failures in the UK and Ireland over a number of slope angles. Evans and Warburton (2010) summarise the frequency of peat slides across various slope angle ranges. Their summary indicates that peat slides are more frequent on slopes between 5 and 20° (predominantly between 5 and ~15°). Therefore, these angles have each been assigned higher scores. The further away the angle is from these ranges, the lower the risk score, as a result of the lower potential energy stored on lower slopes, the decreasing frequency of failures outside these ranges and the lower thicknesses of peat typically found on steeper slopes >20°.

Table 5.2 Slope angle hazard scoring

Slope range (degrees)	Hazard score	Rationale
>20	1	Peat slides are unlikely due to the slope angle increasing drainage and restricting the development of peat.
15-20	4	There are many peat slides recorded in this range of slope angles.
8-15	5	The majority of peat slides described in the literature occur within this range of slope angles.
5-8	3	Although some peat slides have been recorded they are less frequent than on steeper slopes.
2-5	2	Very few peat slides have been recorded on slopes less than 5 degrees.

Slope range (degrees)	Hazard score	Rationale
<2	1	No peat slides are recorded in the literature below 2 degrees.

Peat Depth

The thickness of peat is a key contributory factor in both the likelihood and mechanism of peat instability. Evans and Warburton (2010) have summarised the frequency of peat slides over a range of peat depths. This summary indicates that peat slides are most frequent where the peat is between 1.0m and 2.0m. However, instability has been reported outside of these ranges, up to a depth of 4.5m for peat slides thought the frequency of instability decreases significantly at depths >2.5m. Their reasoning for this is that increased peat depth is commonly associated with greater variance in the humification of the peat profile.

Where the peat depth is less than 0.5m, instability is not typically associated with the peat but rather the underlying mineral substrate. However, whilst reduced, a risk may still remain and as such this is reflected in the scoring system. It should also be noted that no peat instability will occur where no peat or organic soil is recorded and landslides in these areas will be associated with deeper seated failures of the superficial deposits (not assessed here).

Table 5.3 Peat depth hazard scoring

Peat depth (m)	Hazard score	Rationale
>3.5	2	The number of peat slides recorded in peat depths >3.5m are limited in number.
2.0 – 3.5	3	While at a lower frequency comparatively to depths between 1.0m and 2.0m some peat slides have been reported up to 3.5m.
1.0 – 2.0	5	Evans and Warburton (2010) indicate that most reported peat slides (~60 no.) occurred in this range of peat depths.
0.5 – 1.0	3	A limited number of peat slides have been reported at these depths
<0.5	1	Failures are classified a peaty debris slide with failure typically in the substrate material. The number of reported slides with peat depths <0.5m are comparatively few in number.

Slope Curvature

The slope curvature has been suggested as important factor in controlling the susceptibility of the slope to failure by a number of investigations of peat landslides by Dykes & Warburton (2006), Boylan and Long (2011) and Dykes (2008). In addition, investigation of recent slides in Ireland, including the Meenbog slide by Dykes (2022) revealed that the investigated slides had commonly occurring features noted in previous accounts of failures. Dykes (2008 and 2022) summaries the frequency of peat landslides on various slope forms which reveals that peat landslides are much more common on convex slopes.

Boylan et al (2008) suggests that the mechanism of failure on convex slopes is potentially the presence of notably thicker and weaker peat upslope of the break with the peat below being well-drained. In the event of failure it retrogressively progresses upslope with little resistance provided by the lower slopes. On concave slopes Boylan et al conclude that the characteristics of a failure are different as they tend to slide slowly as it is checked by the flatter lower slope and upwelling of peat into ridges. The failure finally tears, thrusting the upper peat on top of the intact peat surface below the concave break and the failure progresses. However, of the failures investigated on concaved slopes evidence of previous slides downslope of the failure were identified and these may have been a more significant factor in causing the slide than the slope form.

The slope curvature hazard scores have been calculated from the OS Terrain 5 DTM and determined in GIS using profile slope curvature analysis to quantify the slope curvature across the Development Site. The DTM was aggregated into 25m cells across the Development Site prior to calculation of the curvature values. The curvature break values for the hazard assessment have been established using standard deviations (std dev) as detailed in **Table 5.4** below. This provides a curvature surface from which to attribute hazard rating scores that correlates well with the findings of the site reconnaissance.

Table 5.4 Slope curvature hazard scoring

Slope form (break values)	Hazard score	Rationale
Concave (>+0.5 std dev)	2	Dykes (2022) indicates that no bog flows have been recorded on concave slopes. Peat slides have been identified on concave slopes but make up only a quarter of the recorded failures and are potentially checked by downslope peat.
Rectilinear (>=-0.5 to <=+0.5 std dev)	3	Dykes (2022) indicates that bog flows are occasionally recorded on rectilinear slopes. Peat slide failures on these slopes make up half of recorded failures.
Convex (<-0.5 std dev)	5	Dykes (2022) indicates that bog flows and peat slides are regularly recorded on convex slopes.

Natural Drainage

Peat hydrology and hydrogeology is complex and differing hydrogeological conditions within the acrotelm and catotelm are demonstrated in a number of studies (Warburton et al, 2004). In general, surface water flows are concentrated through the upper more fibrous acrotelm with flow depths up to 0.2m bgl reported. Catotelmic hydrogeology appears to be dominated by vertical seepage and concentration of flows along peat pipes.

The presence of peat pipes concentrates sub-surface flows through conduits within or at the base of the peat profile. Peat pipes are a ubiquitous feature of upland peat and have been found to be a contributory factor in a number of peat slides reported in the literature. These features supply rainwater to the slide site or substrate (Warburton et al, 2003 and Nichol, 2009) and are therefore considered one of the greatest hazards. However, peat pipes are difficult to identify in the field especially where there is no observable surface expression of the pipe (e.g. depressions, sinks and rises). Although no peat pipes have been identified within the Development Site, given their ubiquity in blanket bogs and the likely influence of land management activities such as furrowing on the frequency of peat pipes (Holden, 2005) their presence cannot be completely disregarded as they are likely to be present (whether dormant or active). As such, where peat depths >1m have been identified, the Development Site has been given a minimum score of 3 for this hazard factor.

The presence of surface drainage features such as flushes and bog pools may give rise to increased vertical migration of surface water through the catotelm leading to increased basal moistening or liquefaction of basal peat (Evans & Warburton, 2010) and resulting in decreased shear strength. In addition, increasing moisture content and waterlogging of the peat will also increase the loading on the slope and basal / substrate pore water pressures. Mills (2003) attributes the presence of drainage features such as flushes discharging to the top of the slide as being a contributory factor in several reported peat slides.

The scores summarised in **Table 5.5** reflect the importance of the drainage feature in supplying rainfall directly to the failure site.

Table 5.5 Natural drainage hazard scoring

Peat depth range (m)	Hazard score	Rationale
Peat pipes	5	A significant drainage pathway, often associated with peat instability. Surface water and rainfall can be rapidly transmitted to the peat / substrate interface in a storm event.
Flushes	4	Flushes have been found to be a contributory factor in peat slides and bog flows under specific circumstances (i.e. blocking drainage lines or draining onto a slope). Flushes allow the storage and transmission of rainfall and increase the mass of the peat.
Bog pool complexes	3	Bog pools are likely to transmit and store large quantities of water at or close to the peat substrate interface resulting in basal moistening and increased buoyancy.
Hummock and hollow complexes	2	Shallow pooling of water is unlikely to result in the rapid transmission of rainwater from the surface to the peat substrate interface but will result in increased loading.
Gullies and no obvious surface features	1	Surface pathways for slope drainage are well established and subsurface drainage is unlikely, so peat landslides not usually recorded in gullied areas.

Artificial Drainage

It has been demonstrated that the presence of drainage ditches and peat grips across a slope may have contributed to peat landslides in studies by authors such as Carling (1986) and Dykes and Kirk (2006). The mechanisms through which drainage ditches have been reported to have contributed to failure include the under cutting of support from upslope peat and interception and rapid transfer of rainwater to failure sites. Warburton et al (2004) indicate that desiccation of the peat in grips may also allow the rapid transfer of rainwater down to the peat / mineral substrate interface where lubrication and increased pore water pressures at the interface can trigger peat slides. In addition, literature evidence suggests that artificial peat drainage is an important influence on the prevalence of peat pipes (discussed above); there are more peat pipes where there is artificial land drainage (Holden, 2005). Peat gripping also interrupts the peat surface removing the confining acrotelm and fragmenting the peat mass.

The scores summarised in **Table 5.6** reflect the three possible scenarios that may direct rainfall to a potential failure site. It should be noted that this category assesses the man-made drainage open ground not the ploughed furrows and drainage channels relating to the commercial forestry. The contribution of the forestry drainage to the overall hazard is assessed separately below.

Table 5.6 Artificial drainage hazard scoring

Feature	Hazard score	Rationale
Peat grips and ditches aligned across slope	5	Peat grips and ditches aligned across the slope have been demonstrated to be a contributory factor in peat slope failures.
Peat grips and ditches aligned down slope	3	Peat grips and ditches aligned down the slope are unlikely to intersect peat pipes and will transfer rainfall rapidly downslope.
No artificial drainage	1	No influence on peat slope stability.

Pre-failure Indicators

Relic failures and pre-failure indicators on a slope provide a strong indication that a slope is pre-disposed to a failure. The hazard rankings for pre-failure indicators are summarised in Error! Reference source not found.. As there were no pre-failure indications identified within the Development Site, a hazard score of 1 has been applied to the whole site.

Table 5.7 Pre-failure indicators hazard scoring

Feature	Hazard score	Rationale
Relic failures	5	Relic peat slides or bog flows on a slope may indicate that slopes with similar conditions may be pre-disposed to failure.
Incipient failure features (tension and compression features)	4	Tension and compression features indicate that a failure is potentially imminent or ongoing and that the slope is strongly pre-disposed to failure.
Peat creep	3	Soil creep generally occurring in shallower peat and lower slope angles may indicate a slope's pre-disposition of rapid failure.
No failure indicators	1	No influence on slope stability.

Forestry

A report on the Derrybrien peat landslide by Lindsay and Bragg (2004) indicated that the alignments of the ploughed furrows within the commercial forestry may have contributed to the failure. The mechanism by which the ploughed furrows potentially contributed was through the drying of the peat by evapotranspiration and interception of rainfall. The drying was noted to have resulted in deep desiccation cracking along furrows essentially leading to the peat being divided into long ribbons with weaknesses between caused by fissuring of the peat. In addition, the loading of the peat by trees may influence peat stability.

EIA Report **Appendix 3A** provides the proposed felling required to facilitate construction of the wind farm. This information has been used to determine the areas of the Development Site that will be felled prior to construction in order to account for the effect of deforestation associated with the Proposed Development.

Table 5.8 Forestry hazard scoring

Feature	Hazard score	Rationale
Deforested, windblown and recently established trees with ploughed furrow perpendicular to the slope	5	The absence of an overlapping tree canopy allows rainfall to re-saturate the peat and any desiccation cracking present may allow rainwater to seep to the peat substrate interface. The ploughed furrows aligned perpendicular to the slope may present lines of weakness in the peat therefore presenting rupture points and leaving only a narrow ribbons resisting failure.
Deforested, windblown and recently established trees with ploughed furrow down the slope	4	The absence of an overlapping tree canopy allows rainfall to resaturate the peat and any desiccation cracking present may allow rainwater to seep to the peat substrate interface. However, ploughed furrows aligned down the slope presents a larger surface to resist failure and less surface water is likely to migrate to the substrate interface.
Forested, ploughed furrow perpendicular to the slope	3	The tree canopy will restrict rainfall reaching and penetrating to the substrate interface, but ploughed furrows aligned perpendicular to the slope may present lines of weakness in the peat.
Forested, ploughed furrow down the slope	2	The tree canopy will restrict rainfall reaching and penetrating to the substrate interface. Ploughed furrows aligned down the slope present a larger surface to resist failure.
Not forested	1	No influence on stability.

Geology

In a number of peat slides described in the literature, the substrate characteristics of the slopes have been considered a possible contributory factor. The presence of particular substrate features such as an iron pan within the soil profile below the peat was reported at three peat slides by Acreman (1991, p. 175). In other studies, Glacial Till deposits were reported at peat slides described by Crisp et al (1964), Tomlinson and Gardiner (1982) and Carling (1986). A basalt derived regolith and ‘rubble’ was noted in the study by Wilson and Hegarty (1993). Nichol (2009) noted patches of smooth rockhead at the head of a peat slide within the Scottish Highlands.

The hazard ranking has been determined by site observations and BGS mapping. Although there were some exposures of the substrate at ground level, there is insufficient data to accurately map the distribution and composition of the Glacial Till underlying the peat across the entire Development Site. However, based on the available observations the deposits appear to be predominantly clayey underlying deep peat and granular underlying shallow peat (<1.0m). As such, the Development Site has been scored on the basis of these observations.

Table 5.9 Geology hazard scoring

Feature	Hazard score	Rationale
Glacial Till and Alluvium	5	Deposits comprising mainly clay are likely to provide a discrete interface where reduced drainage and the formation of iron pans may increase the likelihood of a failure.
Impermeable bedrock	3	Impermeable bedrock, particularly those with smooth planar surfaces will provide reduced resistance to a slide.
Permeable bedrock and granular deposits	1	Significant peat depths are unlikely to form on permeable bedrocks and few slides are associated with granular substrate materials.

5.3 Peat Landslide Stability Assessment

A semi-quantitative peat slope stability assessment has been undertaken in accordance with the methodology detailed within Scottish Government best practice guide (2017). The 'Infinite Slope' method of analysis, after Skempton and DeLory (1957), is the most well established and commonly applied method for the preliminary assessment of peat slope stability.

The factor of safety of a given slope assuming a steady seepage is calculated by comparing the sum of the resisting forces with those of the destabilising/acting forces, given by the following equation:

$$\mathbf{F} = \frac{Shear\ Resistance}{Shear\ Forces} = \frac{c' + (\gamma - m.\gamma w).z.cos^2\beta.tan\phi'}{\gamma.z.sin\beta.cos\beta}$$

Where:

F = Factor of Safety

c' = Effective cohesion

γ = Bulk unit weight of saturated peat

γw = Unit weight of water

m = Height of water table as a fraction of the peat depth

z = Peat depth in the direction of normal stress

β = Angle of the slope to the horizontal

ϕ' = Effective angle of internal friction

As an onerous number of samples would be required to sufficiently characterise the geotechnical parameters of the peat, testing was not undertaken for the preliminary assessment. As such, the geotechnical parameters for this assessment have been obtained from a review of literature sources. A summary of literature values used to inform the stability analysis are presented in **Table 5.9** below.

Table 5.10 Geotechnical parameters of peat derived from literature review

Reference	Effective cohesion c' (kPa)	Effective angle of friction φ' (°)	Unit weight ɣ (kN/m3)	Comments
Hanrahan et al (1967)	5.5 – 6.1	36.6 – 43.5	-	Remoulded H_4 *Sphagnum* peat
Hollingshead and Raymond (1972)	4.0	34	-	-
Landva and La Rochelle (1983)	2.4 – 4.7	27.1 - 35.4	-	*Sphagnum* peat (H3, mainly fibrous)
Carling (1986)	6.52	0	10	-
Rowe and Mylleville (1996)	2.5	28	10.2	Fibrous peat
Kirk (2001)	2.7 – 8.2	26.1 – 30.4		Ombrotrophic blanket peat
Warburton et al (2003)	5.0	23	9.68	Basal peat
Warburton et al (2003)	8.74	21.6	9.68	Fibrous peat
Dykes and Kirk (2006)	3.2	30.4	9.61	Acrotelm
Dykes and Kirk (2006)	4.0	28.8	9.71	Catotelm
O'Kelly and Zhang (2014)	0	28.9 - 30.3	-	Pseudo-fibrous peat
Estimated Design Value	**5.0**	**23**	**10**	**-**

The design values given in **Table 5.10** have been adopted on a site-wide basis. The water table level is assumed to be at ground level (m = 1) to provide a conservative assessment based on flooded conditions (i.e. a worst case scenario such as a high intensity rainfall storm event).

The FoS values for the Proposed Development have been calculated using GIS to derive the F value based on the interpolated peat depth map, DTM and the design values given in **Table 5.10**. In addition, a loaded analysis has been conducted by adding a load of 10 kPa equivalent to the load implied by a 1m high stockpile of peat (for example side cast during road construction) to the shearing forces.

The Factor of Safety results are summarised in **Figure 12** in **Appendix A**.

The best practice guidance suggests that F values of <1.0 should indicate slopes that have or may in future experience failure under the modelled conditions and as such are considered areas of increased risk. However, Boylan *et al* (2008) argue that given the uncertainties in relation to the strength of peat and factors that cause peat landslides a cautious approach should be adopted.

Their study indicates that a relatively high F value should be used to identify slopes with the potential for instability, and as such an F value of 1.4 has been used in this assessment.

The results of the infinite slope analysis for the unloaded scenario indicates that under the modelled conditions, there are no areas of the Development Site with FoS value <1.4 that would be considered susceptible to failure. This corresponds with the findings of field surveys which did not identify any incipient or historical peat slide features within the Development Site.

The loaded analysis indicates that susceptible slopes with FOS values >1.0 but <1.4 are present along a short section of the proposed access track between WTG-01 and WTG-02 in the Carcow Hass area of the Development Site. In addition, potential susceptible slopes with FOS values >1.0 but <1.4 are also identified along parts of the main access track. In the Carcow Hass area of the Development Site, an area with FOS values <1.0 is indicated approximately 230m south of WTG-01. However, none of the Proposed Development infrastructure is located within an area with FOS values <1.0.

Although the preliminary stability assessment indicates that areas of the Proposed Development may be susceptible to failure, there is considerable uncertainty in the geotechnical parameters of peat identified in the literature (Boylan *et al*, 2008) and no site-specific assessment has been undertaken. As such, a pessimistic approach and relatively high factor of safety has been used in the stability assessment. Therefore, the factor of safety values calculated herein should only be considered as indicative of the potential peat slope stability. A detailed assessment of the peat slope stability should be undertaken using site-specific design parameters taken from a ground investigation, particularly where slope angles exceed approximately 3^{o} and peat depths exceed 1m.

6. Peat Landslide Risk Assessment

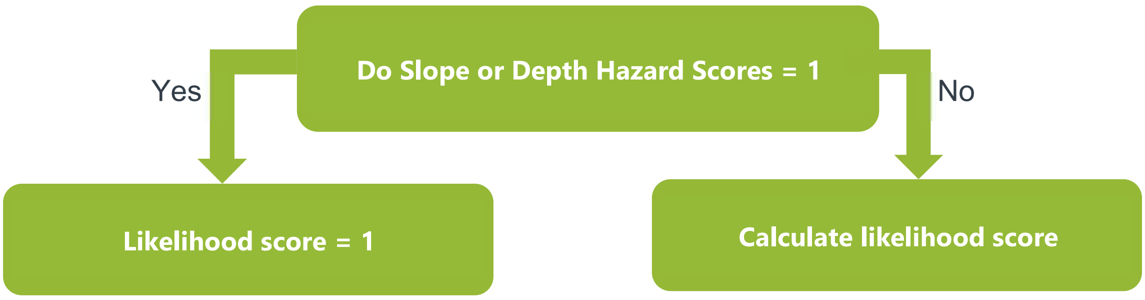
The approach for assessing the risk of a peat landslide occurrence considers the combination of hazards factors (or likelihood assessed above) associated with a particular area of peat multiplied by the consequences of a failure. The assessment of the perceived hazards in combination with the potential consequences (or exposure) represents the assessment of peat landslide risk. This provides a means of identifying areas of the Proposed Development where there is a potential risk of a slide occurring such that preventative measures may be prioritised at an early stage of the development.

6.1 Peat Landslide Likelihood

Hazard scores have been mapped across the Development Site as detailed in Section 5. This has been achieved using GIS to create ranked polygons for each category based on desk-based information and site observations. The polygons have been converted to raster layers using the hazard ranking score and summed using ESRI ArcGIS to provide a peat landslide likelihood score.

The above method does not take account of conditions where a peat slide is unlikely given the slope angle and peat depth conditions. As such, in order to account for this, the key contributory factors of slope angle and peat depth have been used to weight the hazard assessment as shown in **Figure 6.1** below.

Figure 6.1 Peat landslide likelihood weighting



The above method therefore applies to areas where it is considered that a peat landslide is unlikely due to the absence of peat depth and slope conditions that are considered conducive to peat landslide failure.

Based on this system the hazard scores in this assessment range from 1 (negligible likelihood) to a maximum of 40 (almost certain likelihood). **Table 6.1** outlines the hazard score ranges and how these scores relate to the likelihood score taken forwards in the assessment of peat landslide risk. The scoring system also takes into account the infinite slope analysis described in **Section 5.3** to adjust the likelihood scores in areas where the likelihood of failure is increased based on the preliminary geotechnical assessment of peat slope stability.

Table 6.1 Peat landslide likelihood scores

Hazard score	F value	Likelihood	Likelihood score
1-12	>1.4	Negligible	**1**
13-20		Unlikely	**2**
21-28	>1.0 < 1.4	Likely	**3**
29-34		Probable	**4**
35-40	<1.0	Almost Certain	**5**

The result of the likelihood assessment is presented in **Figures 13.0** in **Appendix A**.

The results of the hazard assessment indicate that there are no areas of the Proposed Development considered to be within an area of Almost Certain likelihood. In general, the likelihood of a peat slide is considered Negligible to Likely with the majority of the Proposed Development within areas of Negligible likelihood. The assessment indicates localised areas of Likely likelihood as follows:

- At the northern end of the crane pad for WTG01 where peat thicknesses are up to approximately 1.0m.
- Along parts of the access track between WTG-01 and WTG-02;
- Along parts of the access track between WTG-01 and the substation compound; and,
- Localised sections of main access track leading to substation compound.

6.2 Consequence

A key step in the peat landslide risk assessment is to identify the potential effects that a peat landslide may have on key receptors. The assessment of peat landslide consequences is a qualitative assessment of the effects on key physical and environmental receptors. For the purpose of this assessment the following receptors have been assessed:

- loss of human life;
- public infrastructure (road, rail, utilities and public water supplies);
- property (homes, livestock, commercial forestry, buildings whether occupied or vacant and the proposed development);
- surface water (rivers and streams including protected ecology);
- cultural heritage sites; and,
- ecology (rivers and terrestrial ecology, including priority habitats).

In addition to considering the immediate impacts, the potential long-term impacts such as the cost and time taken for recovery of ecosystems and revegetation are also taken into account as part of the assessment of the consequences.

Peat landslide runout

Predicting the magnitude of a failure and the runout distance is very difficult as this depends on the nature of the peat source and the relative proportions of peat to water (Evans and Warburton, 2010). In addition, peat landslides are likely to be limited by the amount of peat excavated from the source area.

The available accounts of peat landslides studied in the literature indicate that following excavation from the source area ripping and splitting of the peat breaks it down into blocks. In addition, in most accounts a trail of peat slurry is formed, which depends on the initial condition of the peat and the relative proportions of water to peat (Mills, 2002). Through a process of abrasion, splitting and rolling the peat blocks are further broken down into small peat 'peds' (Evans and Warburton, 2010). The runout of a peat landslide is likely to be limited by a number of factors including the initial velocity of the slide, slope curvature, the supply of material from the source area and the roughness of the downslope runout. In addition, the presence of closely spaced trees is likely to affect the practical runout distance due to the presence of interlocking roots below ground and branches above ground.

A study by Mills (2002) indicates that as the failure progresses downslope the excavated material thins and the surface roughness stalls the slide. Mills (2002) summarises the length of runout for numerous peat landslides and bog bursts in the UK and Ireland. This summary indicates that runouts range between 20m and 1.1km from the source area with most in the range of 50m to 750m in length.

Where a peat landslide reaches a watercourse the deposited peat blocks break down rapidly through abrasion and splitting of the blocks as they roll. However, only the largest watercourses have sufficient power to roll large peat blocks during storm events. A smaller watercourse may only have the power to transport small peat blocks and some watercourses may not be able to transport peat at all due to factors such as their dimensions and continuity. Evans and Warburton (2010) indicate that for watercourses able to transport peat blocks their size is likely to decline over a relatively short distance of <200m. Beyond this distance the impacts are likely to be limited to additional sediment loading, some of which may be trapped by vegetation.

An assessment of the receptors exposure to a peat landslide has been undertaken through consideration of the potential runout routes within 750m of the Proposed Development. The exposure assessment has also considered the presence of physical barriers such as watercourses, valleys and the topography, all of which would abruptly redirect or halt a peat landslide. It should be noted that this is a conservative assessment of the exposure and it does not consider the amount or velocity of peat that reaches the receptor. As peat landslides are likely to be source-limited, in reality the runout distances could potentially be much shorter and the amount of peat that reaches a receptor may be negligible due to factors such the depth of peat at the source and surface roughness.

Consequence scoring

As estimated by the infinite slope analysis, the likelihood of a peat slide occurring under the natural unloaded conditions is considered to be negligible. As such, the construction of the proposed wind turbines and associated infrastructure are considered to be the only activities with the potential to significantly alter the peat slope stability (e.g. by cutting). Therefore, the risk assessment only considers the potential consequences on downslope receptors from the layout of the Proposed Development, as if the source was at, or near, the Proposed Development.

The consequences of a peat landslide on the Proposed Development are considered to be relatively minor in comparison to the potential environmental damage, loss of life or the socio-economic impacts caused by damage to public infrastructure and watercourses. A peat landslide is only likely to result in damage to low cost, easily repairable access tracks, hard standings and below ground cables. The consequences of a peat landslide on the Proposed Development have been included in the assessment and are assessed to be moderate as shown in **Table 6.3**.

Table 6.2, Table 6.3 and **Table 6.4** outline the consequence classifications. **Figure 14.0** in **Appendix A** shows the receptors that have been considered in the assessment and illustrates the worst-case consequence scores based on the maximum consequence score from any one of the receptors. It is the maximum consequence score that has been taken forward to the peat landslide risk assessment.

Table 6.2 Consequences for cultural heritage and ecological receptors

Consequence (Score)	Cultural and heritage sites	Ecology (including GWDTE's)
5 - Very High	Potential for damage to Scheduled Monuments of national importance. Receptor is within the potential runout.	Destruction of designated sites. Impacts requiring significant cost and time to restore. Receptor is within the potential runout.
4 - High	-	-
3 - Moderate	Potential for damage to or loss of non-scheduled cultural and heritage sites. Receptor is within the potential runout.	Destruction of sensitive groundwater dependent eco-systems requiring high restoration costs. Receptor is within the potential runout.
2 - Low	-	-
1 – Very Low	No cultural or heritage sites within the potential runout zone.	Destruction of non-designated habitats and ecosystems (e.g. open moorland and farm land). Receptors are not within the potential runout.

Table 6.3 Consequences for man-made receptors

Consequence (score)	Public infrastructure (road, railways, utilities public water supplies)	Property (residential properties, cattle and commercial forestry)
5 - Very High	Damage or blockage of major infrastructure including main line railways, A roads and motorways. Receptor is within the potential runout. Serious damage and potential for death. Long term delays and disruption with very high repair costs and serious social and economic impacts at a regional scale.	Loss of life at a residential property. Receptor is within the potential runout.
4 - High	Damage or blockage of locally significant infrastructure including railways and B roads. Receptor is within the potential runout. Short to medium term delays with high repair costs and social and economic impacts on the local community. High costs to provide temporary measures to maintain supplies / services (e.g. tankered water supply).	-

Consequence (score)	Public infrastructure (road, railways, utilities public water supplies)	Property (residential properties, cattle and commercial forestry)
3 - Moderate	Damage or blockage of C roads. Receptor is within the potential runout. Low repair costs, short term delays and low social and economic impacts on the community.	Damage to fields and pastureland. Loss of livestock. Loss of forestry and damage to plantations. Receptor is within the potential runout. Damage to wind farm infrastructure including the tracks, hard standings and ancillary structures.
2 - Low	Damage or blockage of unclassified roads, tracks and rights of way. Receptor is within the potential runout. Very low repair costs, short term delays and economic impacts on individuals (i.e. residents and landowners).	-
1 – Very Low	The significant impacts of peat slide or bog flow are unlikely to be observed at the receptor.	The significant impacts of peat slide are unlikely to be observed at the receptor.

Table 6.4 Consequences for hydrological receptors

Consequence (score)	Surface water	Water Supplies
5 - Very High	Potential for direct impacts on classified major rivers or lochs[1] such as the Water of Deugh that are within the potential runout zone. Significant impacts including a large reduction of animal populations. Impacts requiring high costs to restock and / or restore. Very high socio-economic impacts (e.g. long term suspension of fishing).	Potential for impacts on water supplies. High cost impacts such a repair and / or replacement or other long term measures.
4 - High	Potential for direct impacts on major tributaries to the classified major rivers or lochs that are within the potential runout zone. Impacts on receptors are likely to be less significant due to break down of peat blocks by rolling, abrasion and splitting during high flows and dilution of contaminants over large distances. Potential for high socio-economic impacts (e.g. reduction in fishing).	-
3 - Moderate	Potential for impacts on less sensitive watercourses >500m upstream classified major rivers or lochs. Block size likely to be significantly reduced over such distances and significant dilution of contaminants over large distances. Impacts requiring lesser restoration works and lesser impact on the watercourse and lochs downstream. Moderate to high socio-economic impacts (e.g. slight reduction in fishing).	Potential for damage to residential private water supplies downstream of the Development Site. Lower cost impacts.

Consequence (score)	Surface water	Water Supplies
2 - Low	Potential for impacts on watercourses that are unlikely to be able to transport peat blocks but finer sediment may be transported to sensitive watercourse. Negligible impacts at downstream rivers or lochs.	-
1 – Very Low	Peat entry into a surface water is unlikely. Negligible impacts at major rivers or lochs downstream.	Very low or no potential for impacts on water supplies.

6.3 Peat Landslide Risk Assessment

The overall risk of a peat slide event has been calculated as the product of the likelihood and consequence score. **Table 6.5** shows the associated risk ranking as derived from **Table 5.3** in the best practice guidance and provides the indicative risk of a peat slide.

Table 6.5 Risk ranking

Likelihood		Consequences				
		Very Low	Low	Moderate	High	Very High
		1	2	3	4	5
Negligible	1	1	2	3	4	5
Unlikely	2	2	4	6	8	10
Likely	3	3	6	9	12	15
Probable	4	4	8	12	16	24
Almost Certain	5	5	10	15	20	25

The suggested actions based on the peat landslide risk are summarised in **Table 6.6** below.

Table 6.6 Suggested actions based on risk ranking

Risk	Suggested Action
>20 - High	Avoid proposed development at these locations.
10 – 19 - Moderate	Proposed development should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible.
5 to 9 - Low	Proposed development may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations.

Risk	Suggested Action
1 to 4 - Negligible	Proposed development should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate.

The results of the peat landslide risk assessment indicate that the Development Site is dominated by areas of Negligible to Low Risk of peat slide failure. This includes the location of WTG-02 and the control building and substation compound which are in areas of Negligible to Low Risk of peat slide failure. The assessment identifies one area of Moderate peat slide risk that is located in the southeast of the Development Site, downslope of the access track running between WTG-01 and WTG-02 (in the Carcow Hass area). It is noted that the area of Moderate risk has been driven by the loaded infinite slope analysis detailed in **Section 5.3**. As the area of Moderate risk is outside the Proposed Development footprint and downslope of the slope break, loading of the slope is unlikely, therefore the risk of a peat landslide is considered to be low.

In the centre of the Proposed Development layout, areas of Low peat slide risk are identified at the crane pad and blade laydown for WTG-01 and along the tracks leading between it and WTG-02 and the substation compound. In addition, areas of Low peat slide risk are identified in six places along the main access track.

Figure 15.0 in **Appendix A** shows the indicative distribution of peat landslide risk throughout the Proposed Development.

7. Mitigation Measures

As discussed in Section 6, under the current conditions the peat landslide risk is considered to be Negligible to Low at the Proposed Development, with localised areas of Moderate risk identified downslope of the section of access track running between WTG-01 and WTG-02, in the Carcow Hass area of the Development Site.

The construction of the Proposed Development and alterations to the Development Site slopes are considered potential triggers (along with other contributory and trigger factors) that may increase a slope's susceptibility to peat instability. In general, the construction practices which should be avoided include the following:

- stockpiling and side casting of excavated materials on or at the top of marginally stable peat-covered slopes;
- loading of susceptible peat by floating roads;
- removal or breaking of acrotelmic peat beneath floating roads;
- removal of support at the toe of peat-covered slopes; and
- poor drainage practices such as the draining of excavations and placement of outfalls on to peat-covered slopes or blocking of drainage channels.

Further discussion on specific mitigation measures is provided in the sub-sections below.

7.1 General considerations

Prior to construction, a detailed ground investigation will be undertaken to assist in detailed design of the Proposed Development as well as any slope modification. This would form part of the planning conditions for the application and is considered the best opportunity to confirm the peat landslide hazard assessments and to perform detailed assessment of the most susceptible slopes based on site specific parameters, observations and the proposed construction methods.

As the ground investigation will require tree felling to facilitate access to the infrastructure locations this would allow supplementary peat surveys to confirm the peat depth where current access constraints prevented surveying. Where access to turbine and other site infrastructure locations was not possible due to the constraints described in **Section 4.1**, post-consent peat surveying is recommended following forestry felling and prior to construction. This is advised to confirm the interpolated peat depths and the findings of the peat landslide risk assessment and to micro-site the infrastructure as necessary to reduce risk.

The ground investigation will aim to provide information on the geotechnical characteristics (e.g. shear strength and bulk density) of the peat and underlying mineral substrate. The results of the ground investigation should inform the development of a geotechnical risk register which should be reviewed and updated at each stage of the post-consent phase of the Proposed Development.

Where possible, the primary mitigation will be to make use of the micro-siting allowances (50m) to further refine the Proposed Development layout in order to locate infrastructure in areas of the shallowest peat or peaty soils.

In addition to the above, targeted visual and quantitative monitoring of slopes susceptible to failure will be performed during construction and a detailed monitoring programme will be developed for sensitive areas prior to construction. Where visual monitoring is undertaken, this will record any signs of tearing, creeping, heaving, subsidence, recent closing of grips / furrows and changes to the peat hydrology. Where necessary monitoring will also include quantitative methods such as surface movement monitoring and measures to support the slope will be implemented.

7.2 Additional considerations in forestry

As part of the ground investigation, it is recommended that the forestry furrows are investigated to determine whether the forestry has resulted in significant drying, desiccation and weakness of the peat. Where the peat has been significantly dried and degraded by the forestry it may exhibit hydrophobic behaviour. As such, it is recommended that the construction is programmed such that sufficient time is given to allow gradual natural rewetting of the peat between removal of the trees and construction of the Proposed Development.

In areas of Low / Moderate risk of a peat landslide where tree felling is proposed, mitigation to address the hazards posed by tree felling should generally include good practice water management such as the following:

- avoiding discharge of water onto peat and where possible water should be directed to purpose-built drainage channels;
- avoiding the accumulation / ponding of water within excavations. Excavations should be pumping out to purpose-built drainage networks;
- diversion of overland flows to a purpose-built drainage network in order to maintain flows and prevent upslope ponding; and
- designing drainage to cater for expected heavy rainfall events such that there is no possibility of water ponding upslope.

In addition to the above, it is recommended that targeted visual and quantitative monitoring of slopes susceptible to failure in felled areas is undertaken throughout construction and a detailed monitoring programme will be developed for sensitive areas prior to construction. Where visual monitoring is undertaken, this will record any signs of tearing and movement of the peat (e.g. by surface monument monitoring) within and near the felled areas and where necessary measures to support the slope will be implemented.

7.3 Excavations

Excavations will be required to accommodate the Proposed Development, at cut tracks, turbine bases, crane pads, blade laydowns, the control building and substation compound, temporary construction compound and battery storage compound. In areas of peaty soils, shallow peat depths and Negligible peat landslide risk, normal best practice construction methods will be employed (e.g. Scottish Renewables, NatureScot, SEPA and Forestry Commission guidance).

Where excavations are proposed in areas of Low risk further detailed assessment will be considered alongside mitigation measures should further assessment confirm the slopes are potentially susceptible to failure. In general, mitigation measures will aim to maintain current drainage routes or divert it to purpose-built drainage networks to reduce the impact on the peat hydrogeology and hydrology, avoid the surface loading of slopes and support the slopes and excavations where necessary. The mitigation measures will include the following:

- a walkover will be undertaken by a suitably qualified and experienced geotechnical engineer and hydrogeologist prior to construction to establish the baseline flow regimes and to identify existing peat pipes and any further signs of instability in order to target mitigation;
- construction activities that require the stripping of peat will be overseen by the geotechnical engineer;

- construction method statements will include awareness of peat instability and pre-failure indicators and will detail conditions for ceasing works. In addition, site inductions, toolbox talks and training will be incorporated to ensure all site personnel are able to recognise the signs of instability;
- where necessary a purpose-built drainage network that intercepts surface water from flushes, grips and drainage ditches will be constructed. This will be designed with adequate capacity to cater for the expected heavy or prolonged rainfall events;
- regular inspection of the upslope area of excavations and tracks for ponding caused by the Proposed Development will be undertaken, and where this occurs, measures to drain ponded water to the drainage network will be implemented;
- where interception of surface water either side of the crane pads and tracks is not proposed, it will be designed in a manner that allows downslope throughflow through the foundation so that ponding upslope is avoided. This will include the installation of free-draining material and / or perforated pipes beneath hard standings and tracks where flushes are identified. Where peat pipes, grips and ditches are discovered during construction, flows through the track or crane pad will mimic the natural flows;
- cut-off drainage ditches upslope of the excavations will be constructed to divert flows to the purpose-built drainage network and avoid ponding in excavations. Where ponding in excavations occurs (e.g. from rainfall or groundwater) it will be pumped out to the drainage network;
- outfalls and drainage onto the peat will be avoided. Where an outfall will drain to an existing channel, measures will be installed to avoid erosion and headward gully formation;
- drainage channels and flows through tracks and hard standing will be periodically checked during construction, particularly after any storm event to ensure their continuing and effective functionality;
- excavated spoil, rock and peat will not be stored on slopes with a Moderate risk of peat landslide;
- where infrastructure undercuts a peat-covered slope with a Moderate risk of peat landslide, visual monitoring of the slope will be conducted regularly during construction and measures to support the slope will be implemented as necessary; and,
- Excavations through deep peat will be appropriately designed to prevent collapse of the peat into excavations and the development of tension cracks. Where battering is proposed, regular monitoring of the peat surrounding the excavation for signs of movement and seepage at the substrate interface would be performed daily alongside normal pre-work checks.

In addition, to avoid water ponding upslope of the track, storage locations for excavated spoil, rock and peat will be carefully selected to avoid loading moderately stable slopes or slopes with peat depths >1m.

7.4 Floating roads

Best practice guidance on the design and construction of floating roads on peat is well documented by NatureScot (2015) and Forestry and Land Scotland (2010) and the guidance and methods presented therein will be implemented. The suitability of a slope for construction of a floating road will take into account the peat landslide risks.

Where floating roads are required, the route will be subject to detailed ground investigation including an assessment of the bearing capacity of the peat in relation to the maximum loads it may experience, loading rates and slope stability. In addition, the route of the floating road will be walked to identify the location of possible surface and sub-surface peat drainage features crossing the proposed routes in order to target mitigation measures. These measures will aim to maintain and mimic these drainage routes and avoid focussing them on to susceptible slopes. This may require non-intrusive methods of ground investigation to identify as many of the sub-surface features as possible. Furthermore, the walkover and detailed design of the access tracks will micro-site tracks away from convex breaks in slope and very wet ground.

During construction regular visual and quantitative monitoring of floating tracks on susceptible slopes will be undertaken to identify any potential indications of movements including slippage, failures and tearing of the peat.

In addition to the above, further mitigation measures that will be required include the following:

- surface vegetation and acrotelmic peat will be left *in-situ* to provide additional strength and support;
- floating road construction will be conducted at a rate which allows sufficient time for the peat to 'rebound' and regain strength. This may involve applying aggregates in a number of layers and monitoring of settlement;
- Construction of the floating roads will be conducted outward from the starting point so as to limit loadings directly onto peat by construction traffic; and
- Measures to limit the weight of delivery vehicles may be required to reduce loading onto the peat during construction.

The above mitigation measures will also be required at locations where displacement or floated/piled crane pads are required.

7.5 Side casting and stockpiling

An Outline Peat Management Plan ('PMP') detailing the measures for handling and storage of peat and the design and selection of peat and subsoil storage areas has been prepared separately to this peat landslide risk assessment (EIA Report **Appendix 6.A**). The recommendations of the PMP will be followed throughout the construction of the Proposed Development and storage areas will be confirmed through detailed ground investigation and confirmation of the peat landslide risks at the stockpiling areas.

Storage of excavated materials on slopes with peat depths >1m and areas with Low or Moderate peat landslide susceptibility should be avoided. Where storing of materials in these areas is unavoidable, a detailed assessment of their stability will be undertaken during the post-consent ground investigation and mitigation measures similar to those for floating and cut tracks will be employed accordingly.

8. Conclusions and Recommendations

8.1 Conclusions

Published Soil Survey of Scotland and BGS mapping indicates that the Development Site is predominantly underlain by blanket peat with areas of peaty soils also present in places. The geological mapping indicates the presence of Peat through the centre of the Development Site with the remainder of the Development Site underlain by Glacial Till and thin or absent deposits. The Development Site is underlain by bedrock formations comprising wacke and mudstone.

A programme of peat depth surveys has been undertaken at the Proposed Development over two phases that identified a limited number of areas with peat depths >0.5m. The deepest thicknesses of peat were identified along the main access track to the Development Site adjacent to the Glenhastel Burn crossing and in a localised area west of Auchincally Hill. Peat depths of between 0.7m and 1.2m were also recorded along the route of the proposed access track from WTG-01 and Stradlund Hill. In general, the areas of peat with depths >0.5m identified by the peat surveys cover a smaller area than the mapped locations of peat in BGS and Soil Survey Mapping.

An assessment of peat landslide hazards has been undertaken to assess the likelihood of a peat landslide failure within the Development Site. The results of the hazard assessment indicate that there are no areas of the Proposed Development layout considered to be within an area of Almost Certain likelihood. The likelihood of a peat slide is generally considered to be Negligible to Likely with the majority of the Proposed Development within areas of Negligible likelihood. However, an area of Almost Certain likelihood has been identified downslope to the east of the section of the track running between WTG-01 and WTG-02, in the Carcow Hass area of the Development Site.

A quantitative assessment of the peat slope stability based on the infinite slope model reveals that under unloaded conditions using the typical parameters derived from literature sources, factor of safety values are generally in excess of F=1.4. This corresponds with the findings of the field surveys that did not identify any evidence of peat slides within the Development Site. In the loaded scenario, the majority of the Development Site contains F values >1.4 but areas with F values <1.4 are identified downslope to the east of the track between WTG-01 and WTG-02 in the Carcow Hass area of the Development Site.

The peat landslide risk assessment, using the method outlined in the best practice guide, indicates that the Development Site is at a Negligible to Low risk of peat landslide failure. However, an area of Moderate risk is identified to the east of the track between WTG-01 and WTG-02 in the Carcow Hass area of the Development Site. This is likely to be as a result of the higher peat landslide susceptibility based on the infinite slope analysis in the loaded scenario which assumed loading the entire Development Site with an additional 1.0m of peat. However, given that no development is proposed in this area of the Development Site, the likelihood of failure is considered unlikely and the risk is considered to be low.

8.2 Recommendations

A post-consent detailed ground investigation is recommended to assist in detailed assessment of peat slope stability in the most sensitive areas of the Proposed Development. The ground investigation should also aim to establish the nature and geotechnical parameters of the peat and peat substrate interface. It is recommended that ground investigation information is used to check / verify the peat slope stability assessments. Where access to the proposed location of infrastructure was not possible during the peat survey due to the access constraints due to forestry presence, additional probing in these areas is recommended to confirm the modelled peat depths and peat landslide risk assessment.

The assessment indicates that the Development Site is largely at a Negligible to Low risk of peat landslide failure and while there is an area of Moderate risk located to the east of the track between WTG-01 and WTG-02 in the Carcow Hass area, the likelihood of failure is considered unlikely and the risk therefore low as no development is proposed in this area. Should the detailed pre-construction ground investigations identify features that may increase the susceptibility of peat to slide (e.g. peat pipes and flushes), the primary mitigation to be employed will be use of the micro-siting allowance (50m). Where necessary to further reduce risk, the Proposed Development layout would be refined within the micro-siting allowance to locate infrastructure in areas of the shallowest peat or peaty soils.

Other mitigation measures employed would be to minimise additional loading of susceptible peat covered slopes, maintain the current drainage of the peat, avoid ponding of surface water and where necessary redirect drainage to a purpose-built network. In addition, monitoring of slopes may be required where a detailed ground investigation of the proposed infrastructure confirms that sensitive slopes may be moderately susceptible to peat landslides.

In conjunction with the above, a geotechnical risk register should be developed and maintained by a geotechnical engineer throughout the life cycle of the Proposed Development. During construction, a Geotechnical Clerk of Works should also be present on site to monitor sensitive slopes for movement and to manage any changes to the peat landslide risks.

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Appendix A
Figures

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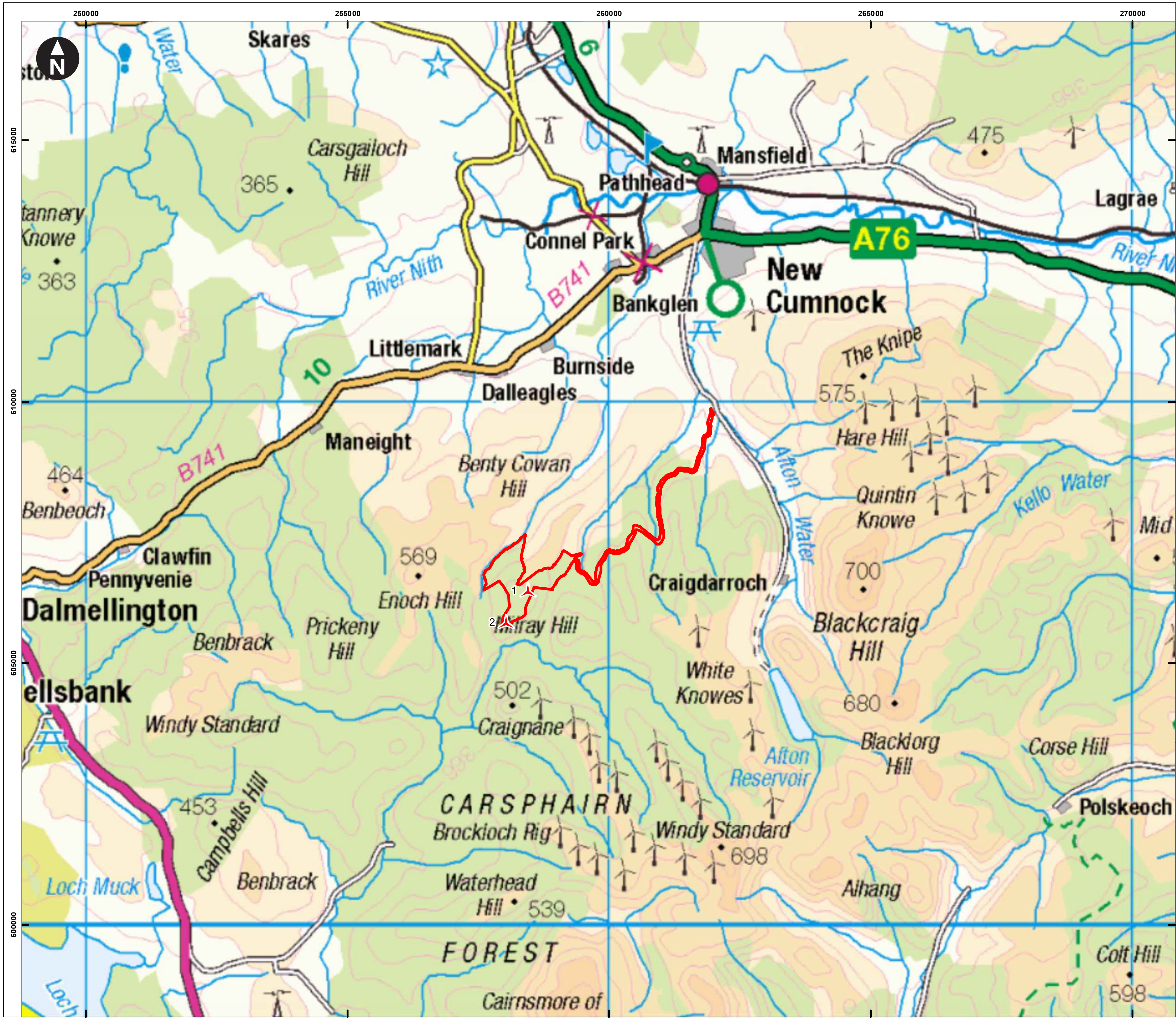

Key

Site boundary

Turbine location

0 1 2 3 km

Scale at A3: 1:70,000

Client

RWE

Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 1
Site location plan

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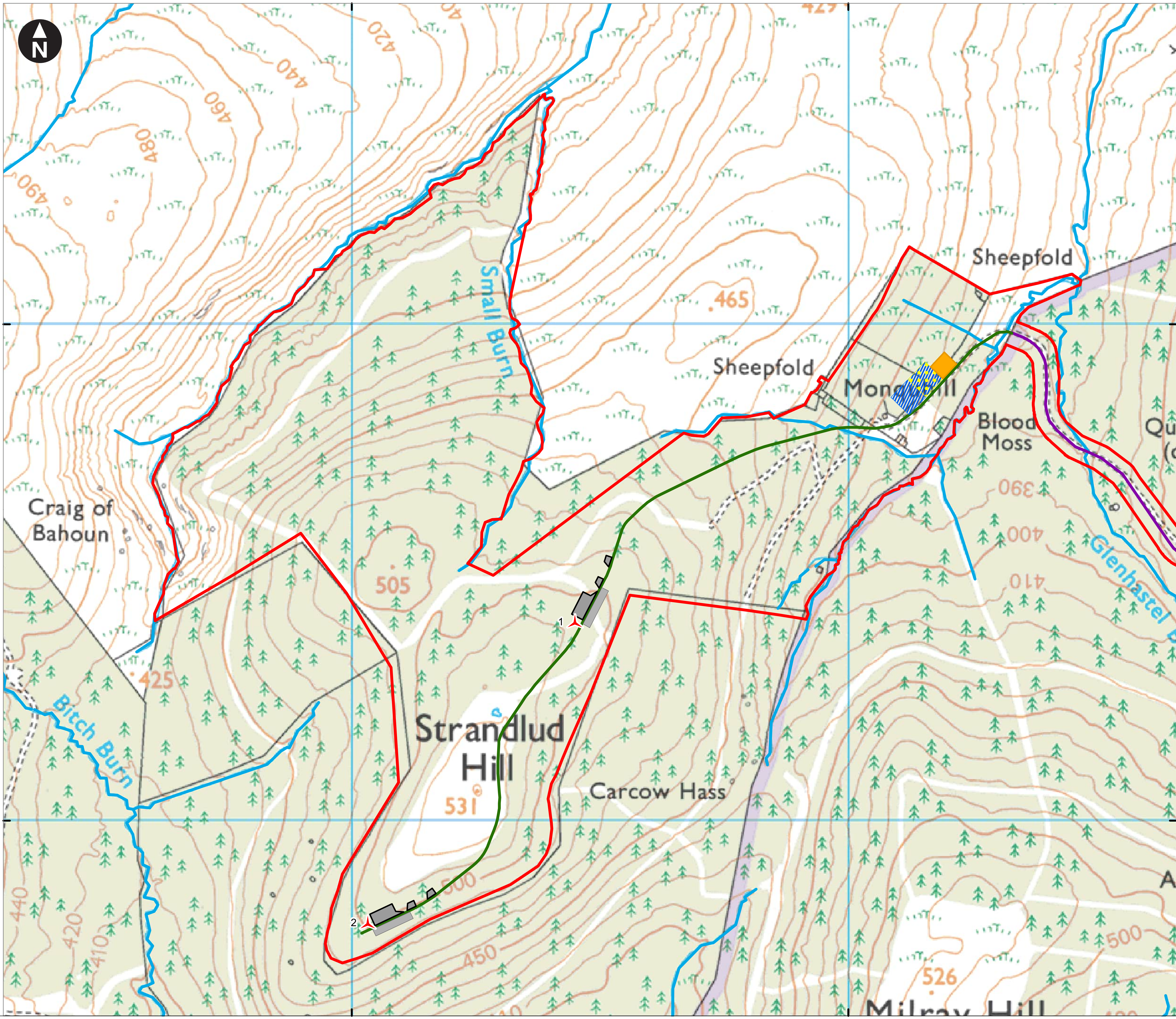

Key

- Site boundary
- Turbine location
- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Surface water

Minor infrastructure not shown due to scale

0 200 400 m

Scale at A3: 1:7,500

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Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 2
Site layout

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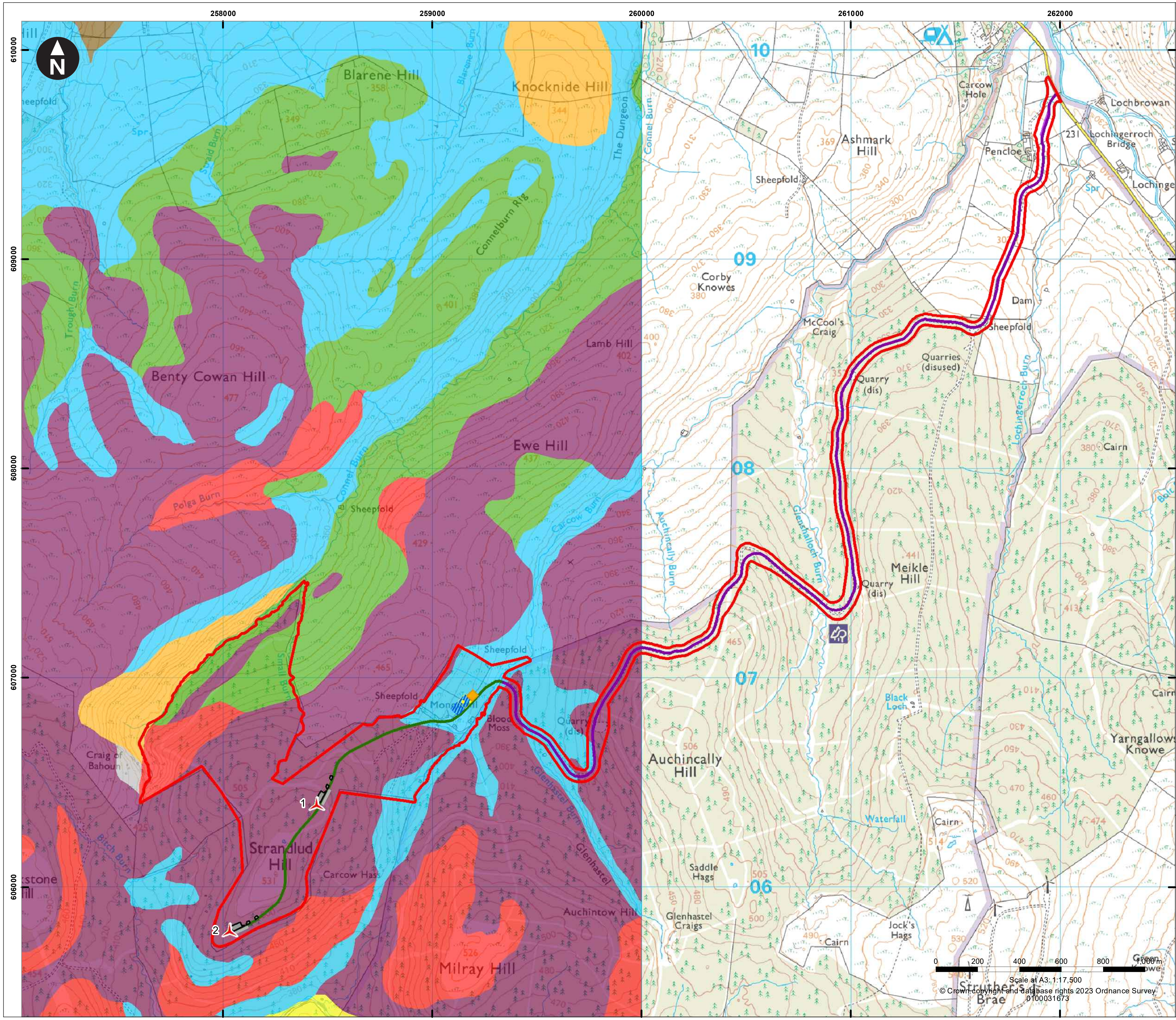

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Key

- Site boundary
- Turbine location
- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage

Generalised Soil Type

- Alluvial soils
- Brown soils
- Immature soils
- Mineral gleys
- Mineral podzols
- Peat
- Peaty gleys
- Peaty podzols

Minor infrastructure not shown due to scale

Note:
Soil Survey of Scotland Staff (1970-1987). Soil maps of Scotland (partial coverage). Digital version 10 release. Phase copyright and database right The James Hutton Institute July 2022. Used with the permission of The James Hutton Institute. All rights reserved. Any public sector information contained in these data are licenced under the Open Government Licence v.2.0.

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Peat Landslide Risk Assessment

Figure 3
Soil Map of Scotland (1:25,000 partial cover, version 10)

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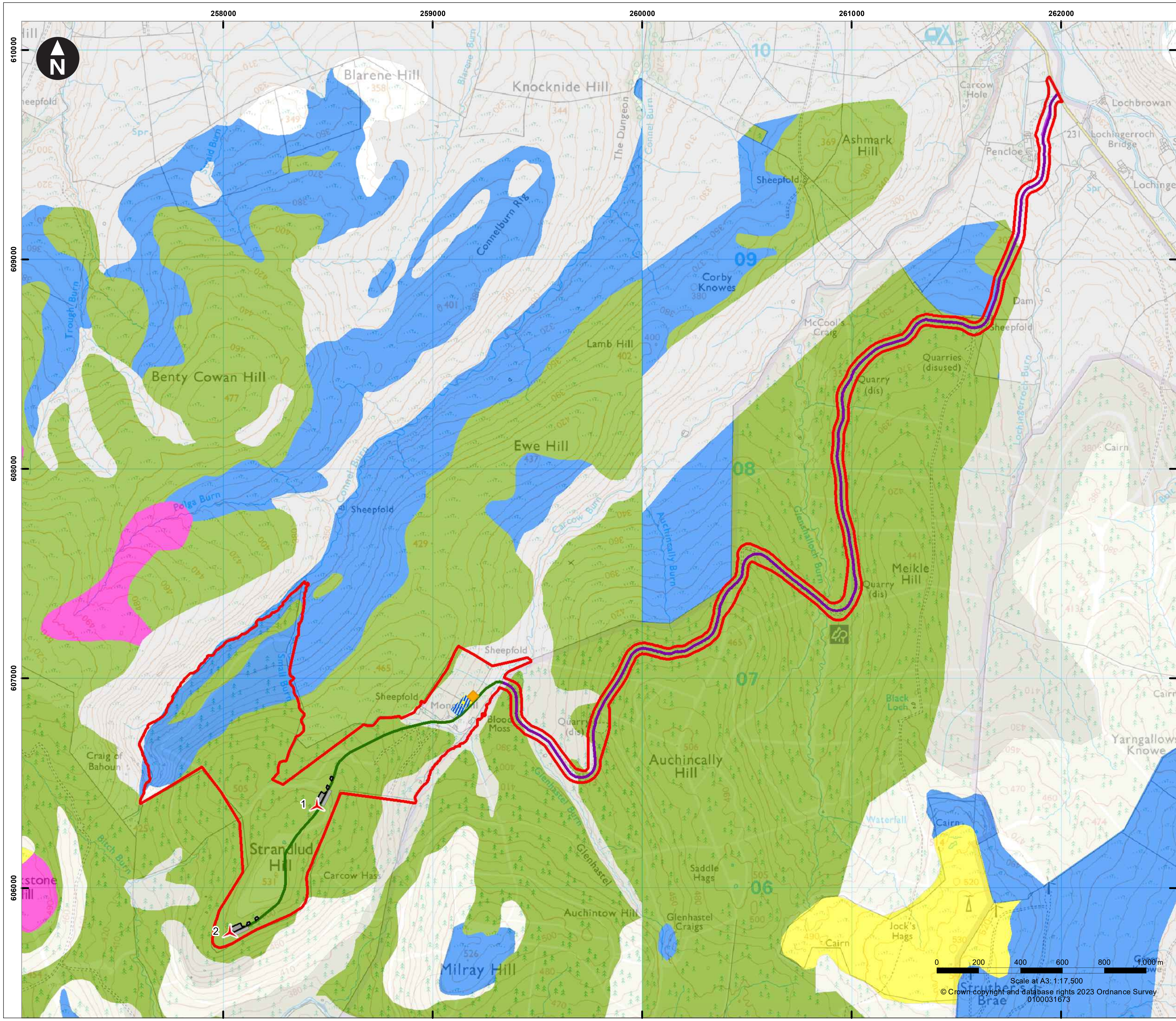

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Key

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- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage

SNH Soil Carbon Classification

- Class -2: Non-soil
- Class 0: Mineral soils
- Class 1: Carbon-rich and deep peat with all cover priority peatland habitats
- Class 2: Carbon-rich and deep peat with cover dominated by peatland habitats
- Class 3: Mostly carbon-rich soils with some deep peat and occasional peatland habitats
- Class 4: Area unlikely to include carbon-rich soils
- Class 5: No peatland habitat recorded

Minor infrastructure not shown due to scale

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Peat Landslide Risk Assessment

Figure 4
Carbon and peatland map

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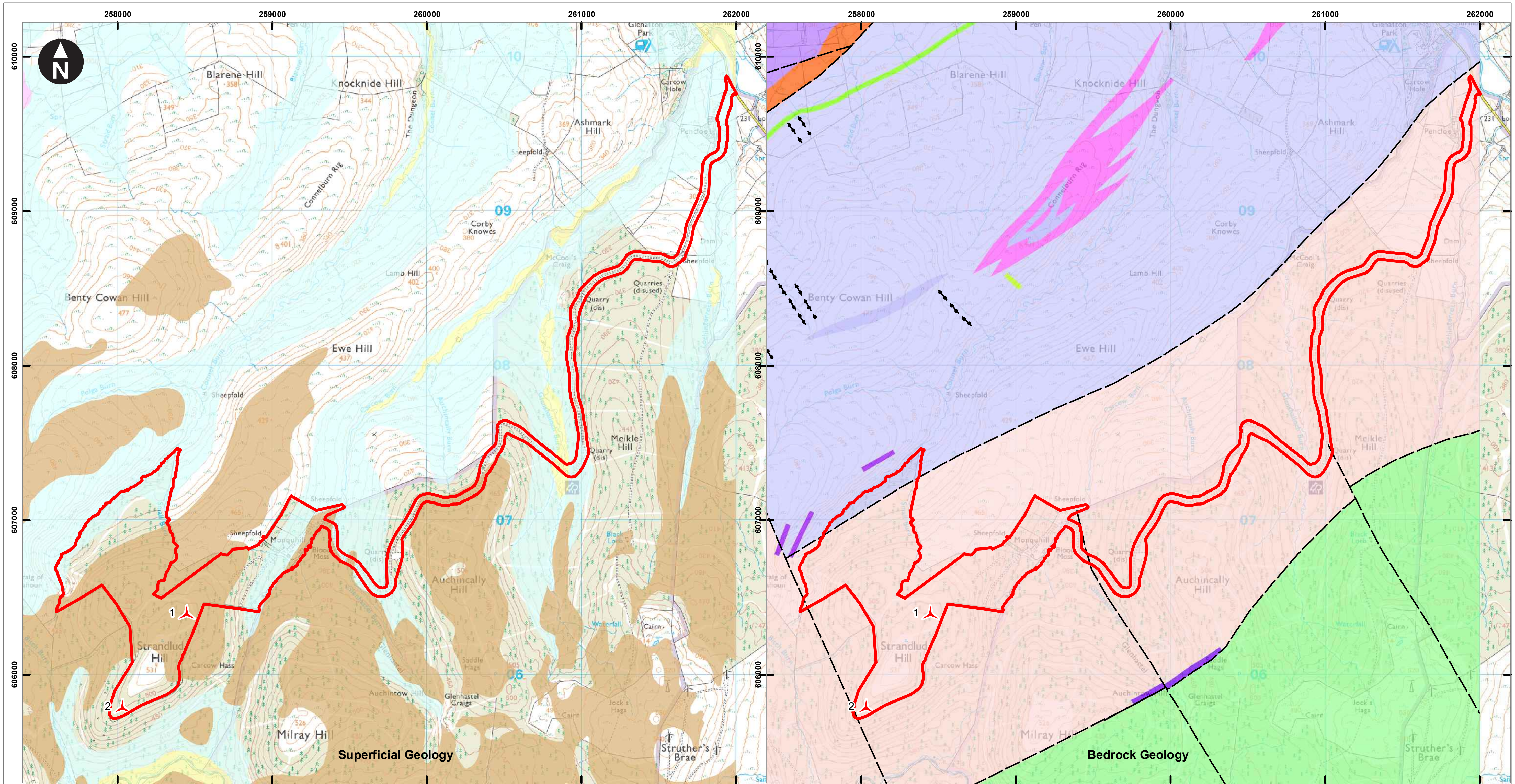

Key

Site boundary

Turbine location

Superficial Geology

ALLUVIUM - SILT, SAND AND GRAVEL

TILL, DEVENSIAN - DIAMICTON

GLACIOFLUVIAL DEPOSITS - GRAVEL, SAND AND SILT

PEAT - PEAT

Bedorck Geology

CUMBRAE-STEVENSTON DYKE - ANDESITE

CARRICK VOLCANIC FORMATION - BASALT AND BASALTIC ANDESITE

SOUTHERN MIDLAND VALLEY FELSITE SILLS - FELSITE

NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE - ANDESITE

NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE - MICRODIORITIC-ROCK

BLACKCRAIG FORMATION - CONGLOMERATE

BLACKCRAIG FORMATION - WACKE

KIRKCOLM FORMATION - WACKE

MARCHBURN FORMATION - CONGLOMERATE

MARCHBURN FORMATION - WACKE

CRAWFORD GROUP - BASALT, LAVA-PILLOWED

CRAWFORD GROUP - MUDSTONE AND CHERT

UNNAMED IGNEOUS INTRUSION OF UNKNOWN AGE - MAFITE

Fault, inferred, displacement unknown

Mineral vein, inferred

0 200 400 600 m

Scale at A3: 1:25,000

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Peat Landslide Risk Assessment

Figure 5
BGS geology

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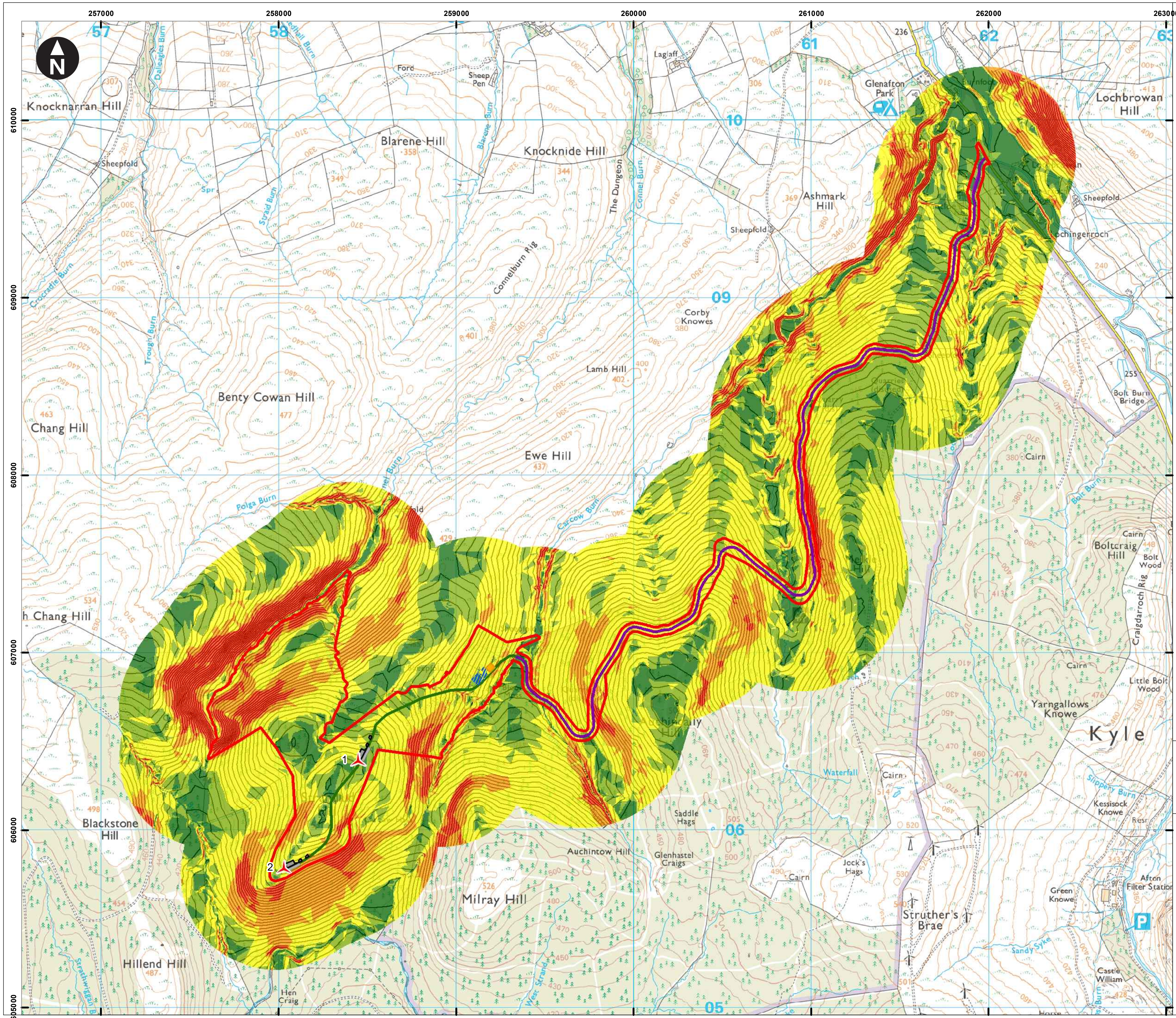

Key

- Site boundary
- Turbine location
- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage

OS Terrain 5m Slope Angle (degrees)

- 0 - 5
- 5 - 8
- 8 - 15
- 15 - 20
- >20
- OS Terrain 5m Elevation Contours (5m)

Minor infrastructure not shown due to scale

0 200 400 600 800 1,000 1,200 m

Scale at A3: 1:20,596

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Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 6
OS terrain 5 slope analysis

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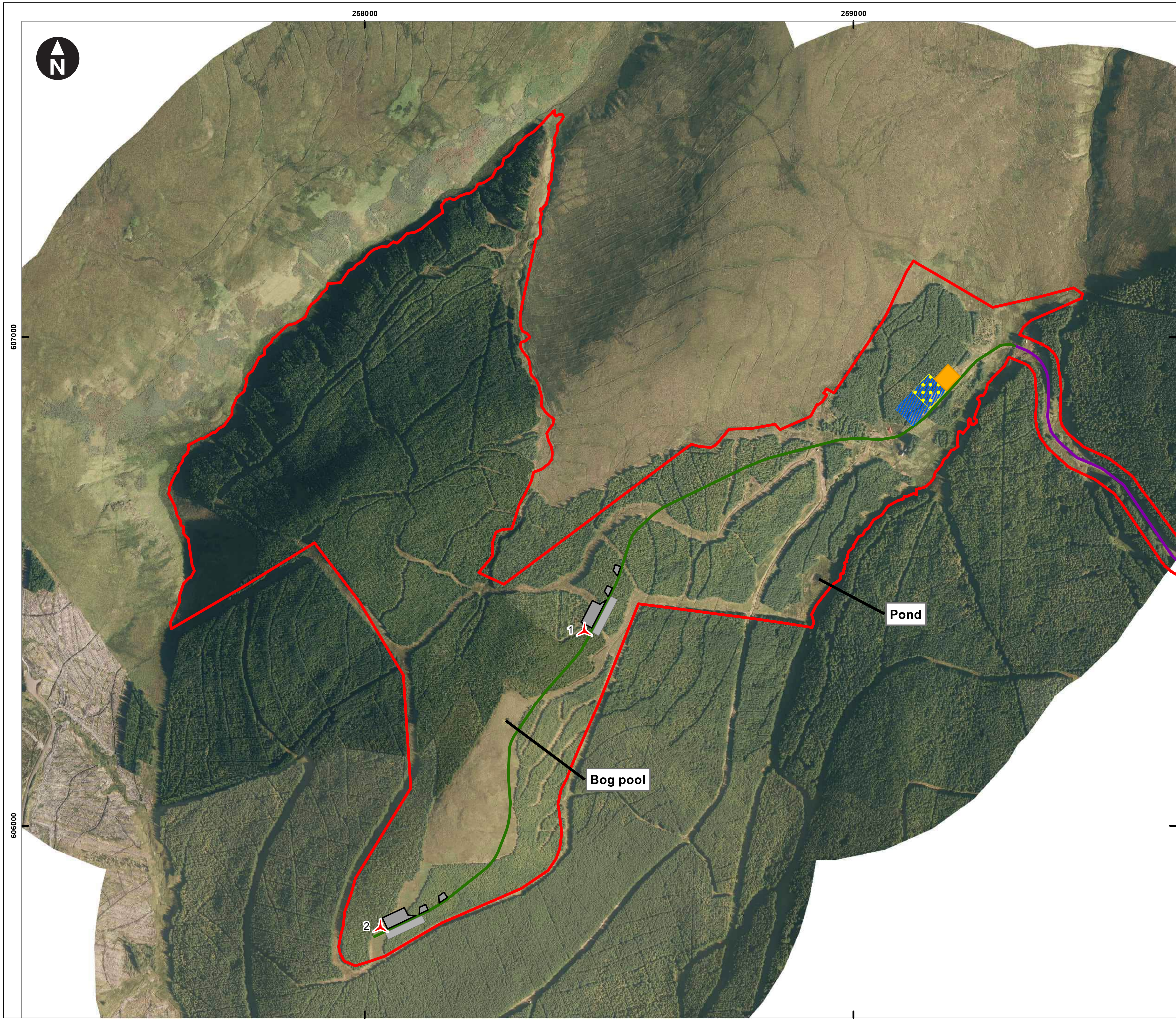

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- Turbine location
- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route

Minor infrastructure not shown due to scale

0 200 400 m

Scale at A3: 1:7,500

Client

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Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 7
Aerial imagery

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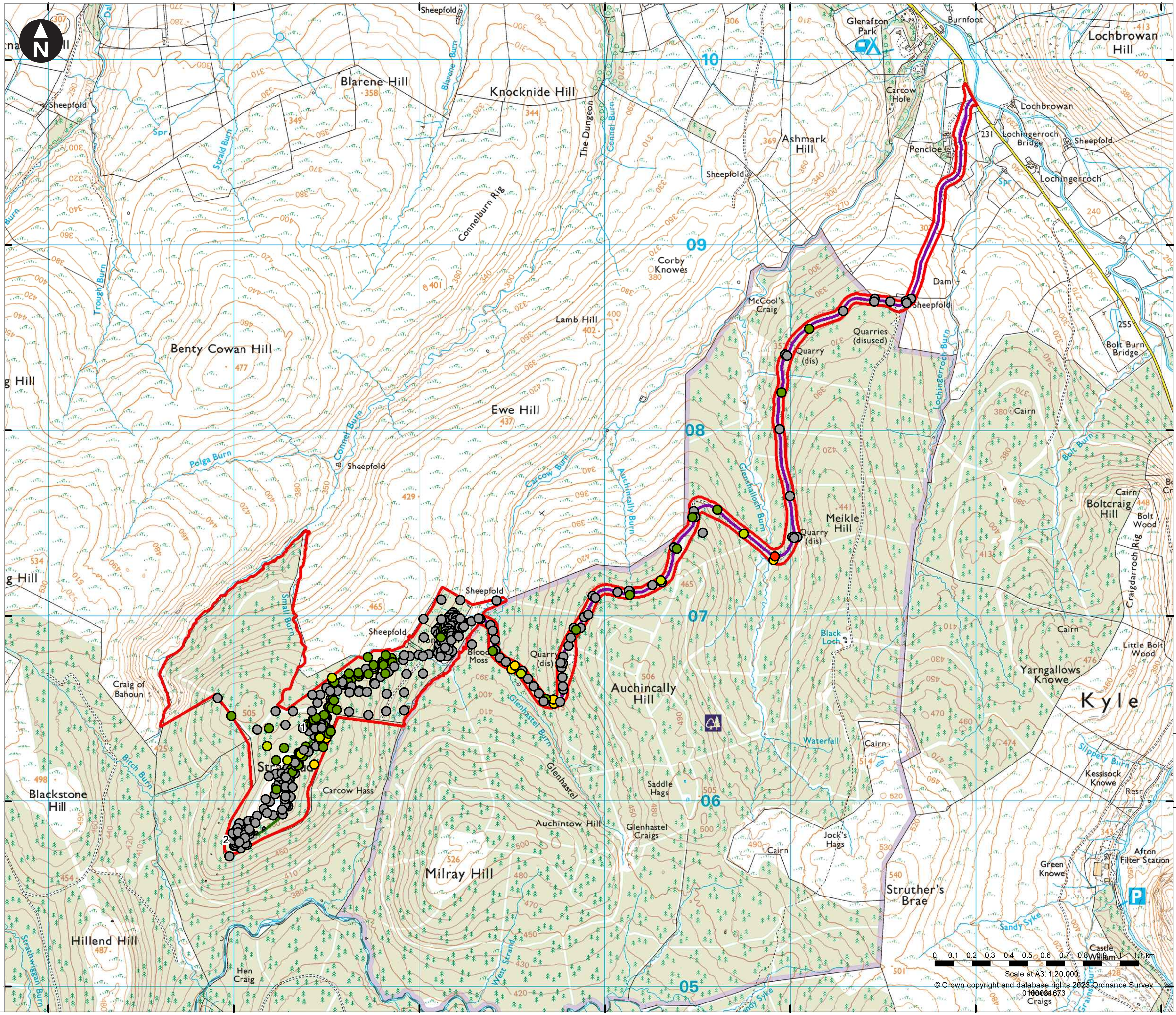


Key

- Site boundary
- Turbine location
- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

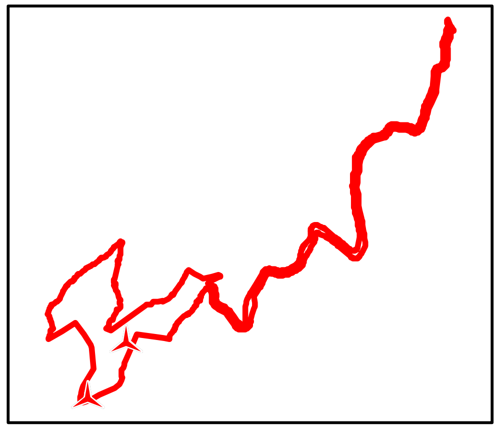
Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage

Peat Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0

Minor infrastructure not shown due to scale



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Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 8.0
Peat Depth Survey Results

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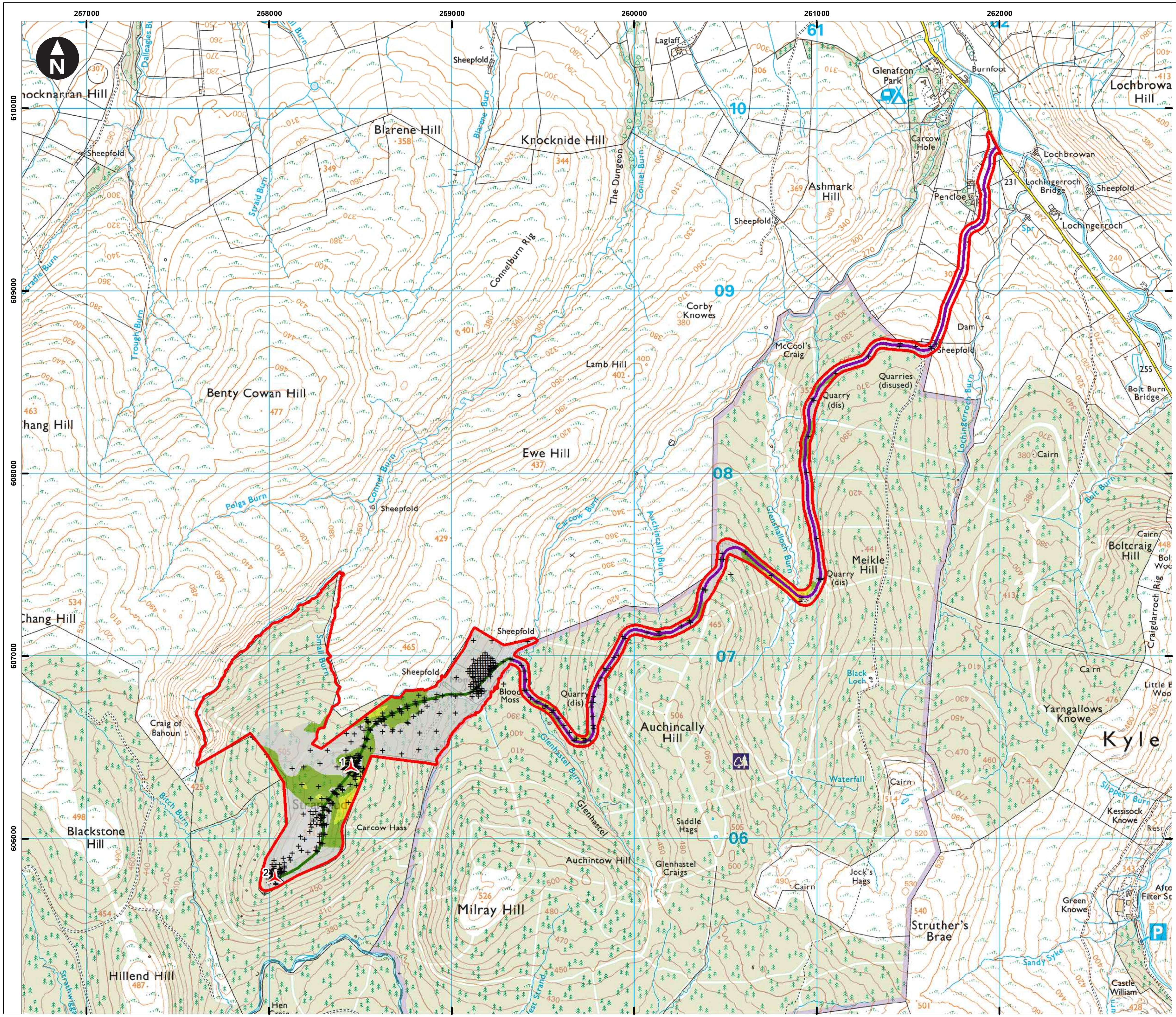

Key

- Site boundary
- Turbine location

Access Track

- Onsite access tracks
- Pencloe Forest access route

Interpolated Peat Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- + Peat survey points

Minor infrastructure not shown due to scale

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 km

Scale at A3: 1:20,000

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Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 9.0
Interpolated Peat Depth

August 2023

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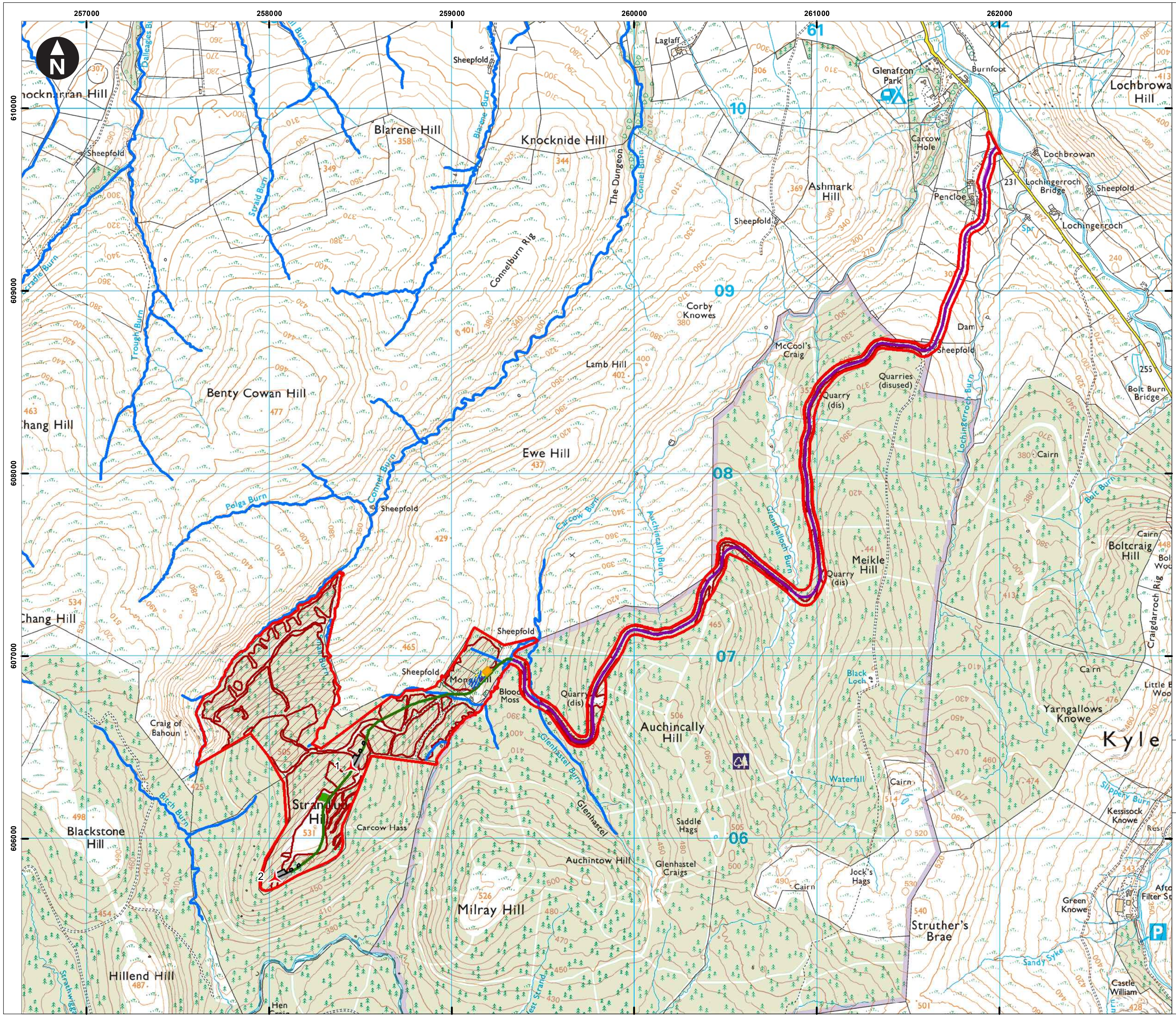

Key

- Site boundary
- Turbine location
- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage
- Watercourses
- Forestry
- Bog pool

Minor infrastructure not shown due to scale

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 km

Scale at A3: 1:20,000

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Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 10.0
Geomorphology

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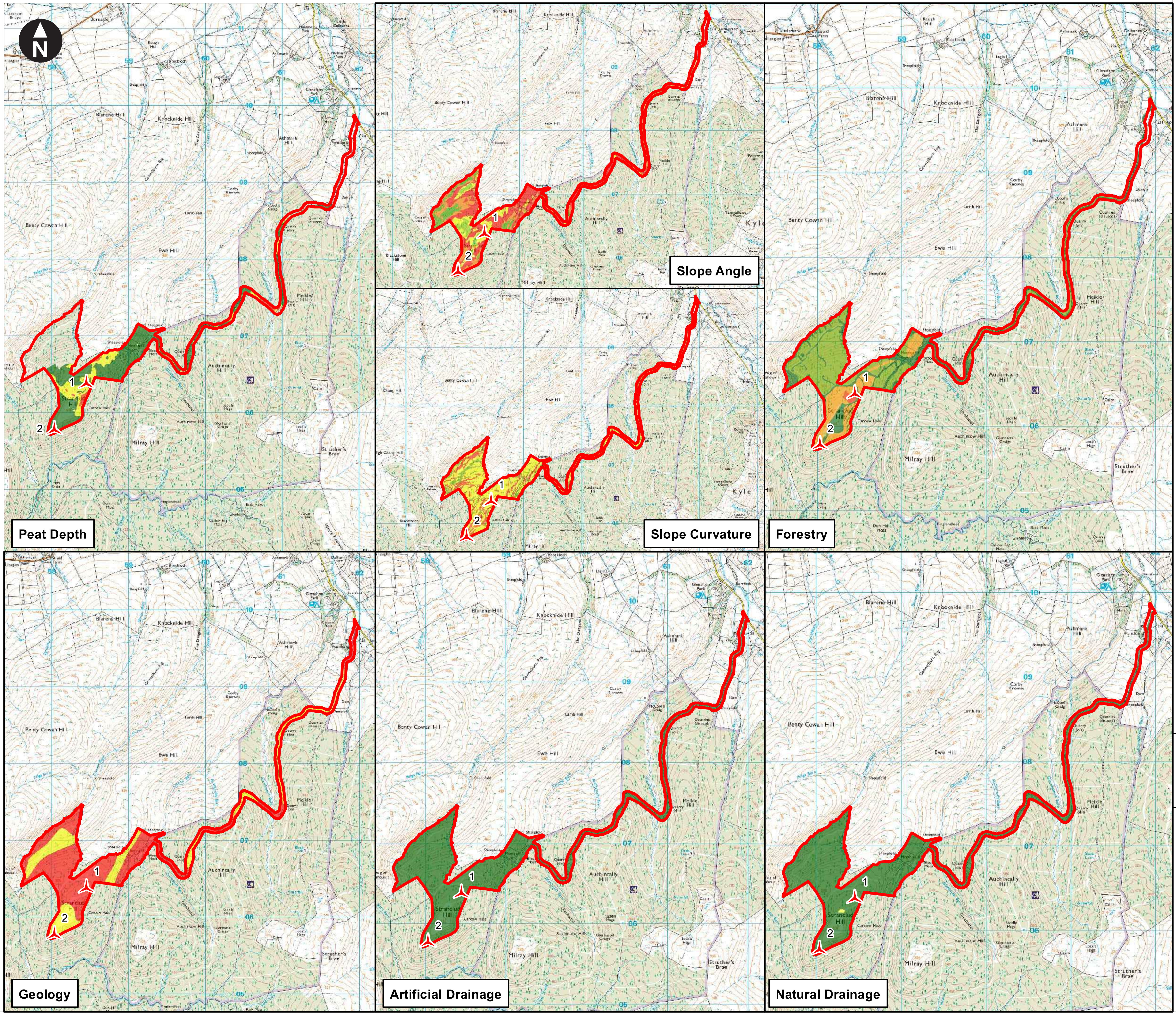

Key

Site boundary

Turbine location

Hazard Scores

1 (Insignificant)

2 (Significant)

3 (Substantial)

4 (Serious)

5 (Extremely Serious)

Not to scale

Client

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Enoch Hill 2
Peat Landslide Risk Assessment

Figure 11.0
Peat Landslide Hazard Scores

July 2023

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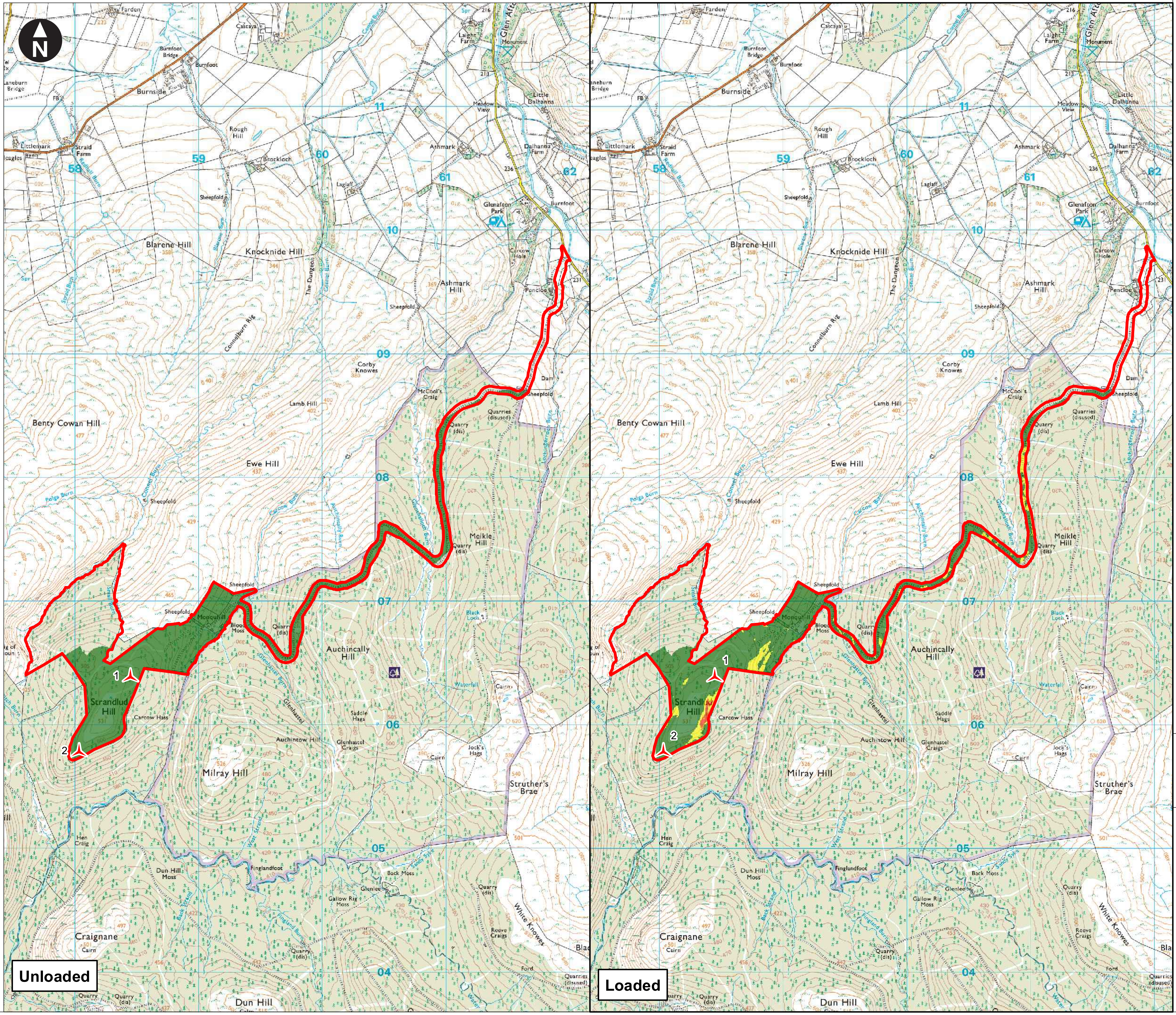

Key

- Site boundary
- Turbine location

Factor of Safety

- <1.0
- 1.0 - 1.4
- >1.4

0 0.25 0.5 0.75 1 1.25 1.5 1.75 km

Scale at A3: 1:30,000

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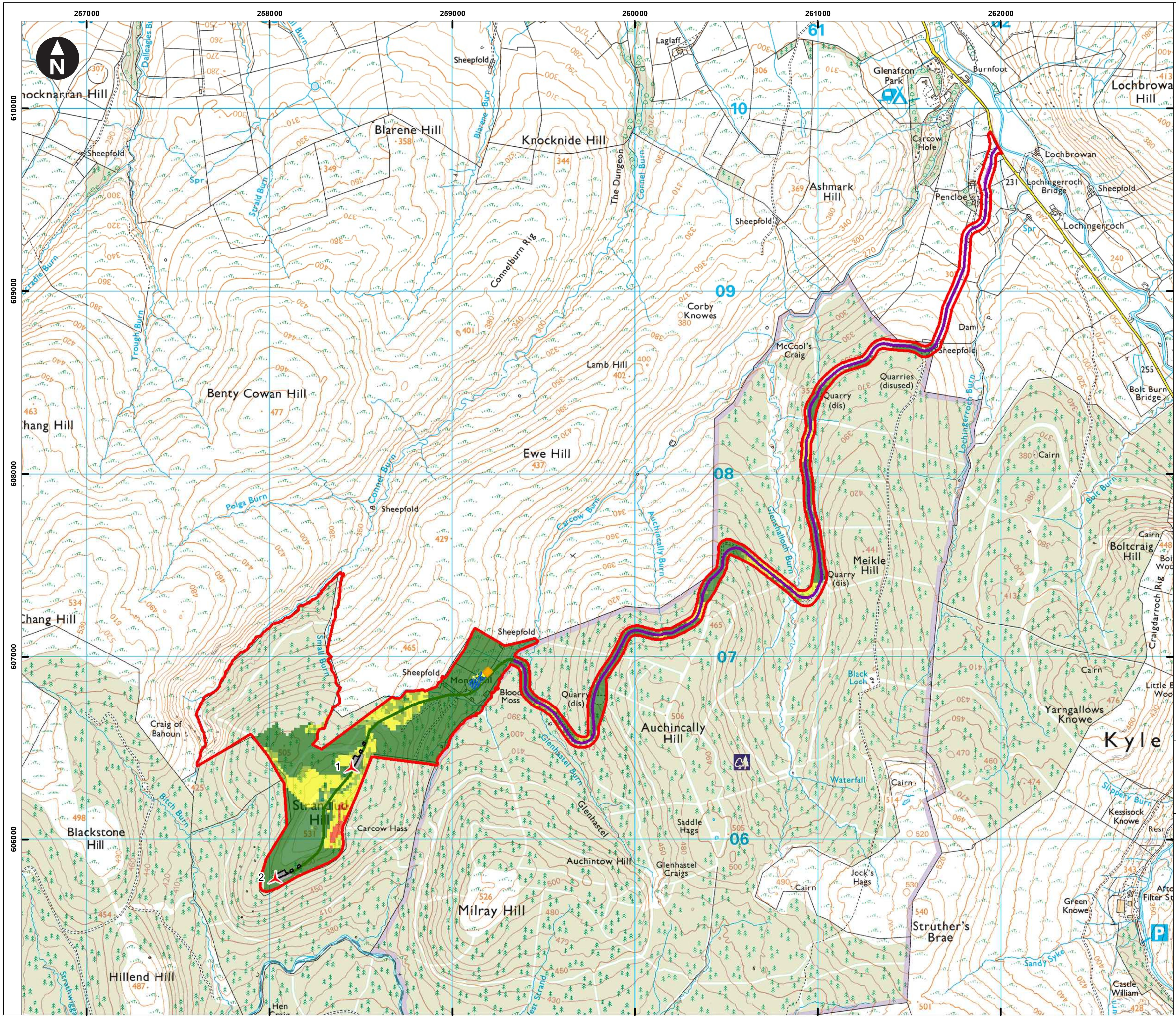
Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 12.0
Infinite Slope Analysis

July 2023

wsp



Key

- Site boundary
- Turbine location
- Primary and auxiliary crane pads (refer to figure 3.4 for crane pad layout)
- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage

Peat Landslide Likelihood

- 1 (Negligible)
- 2 (Unlikely)
- 3 (Likely)
- 4 (Probable)
- 5 (Almost Certain)

Minor infrastructure not shown due to scale

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 km

Scale at A3: 1:20,000

Client

RWE

Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 13.0
Peat Landslide Likelihood

August 2023

wsp

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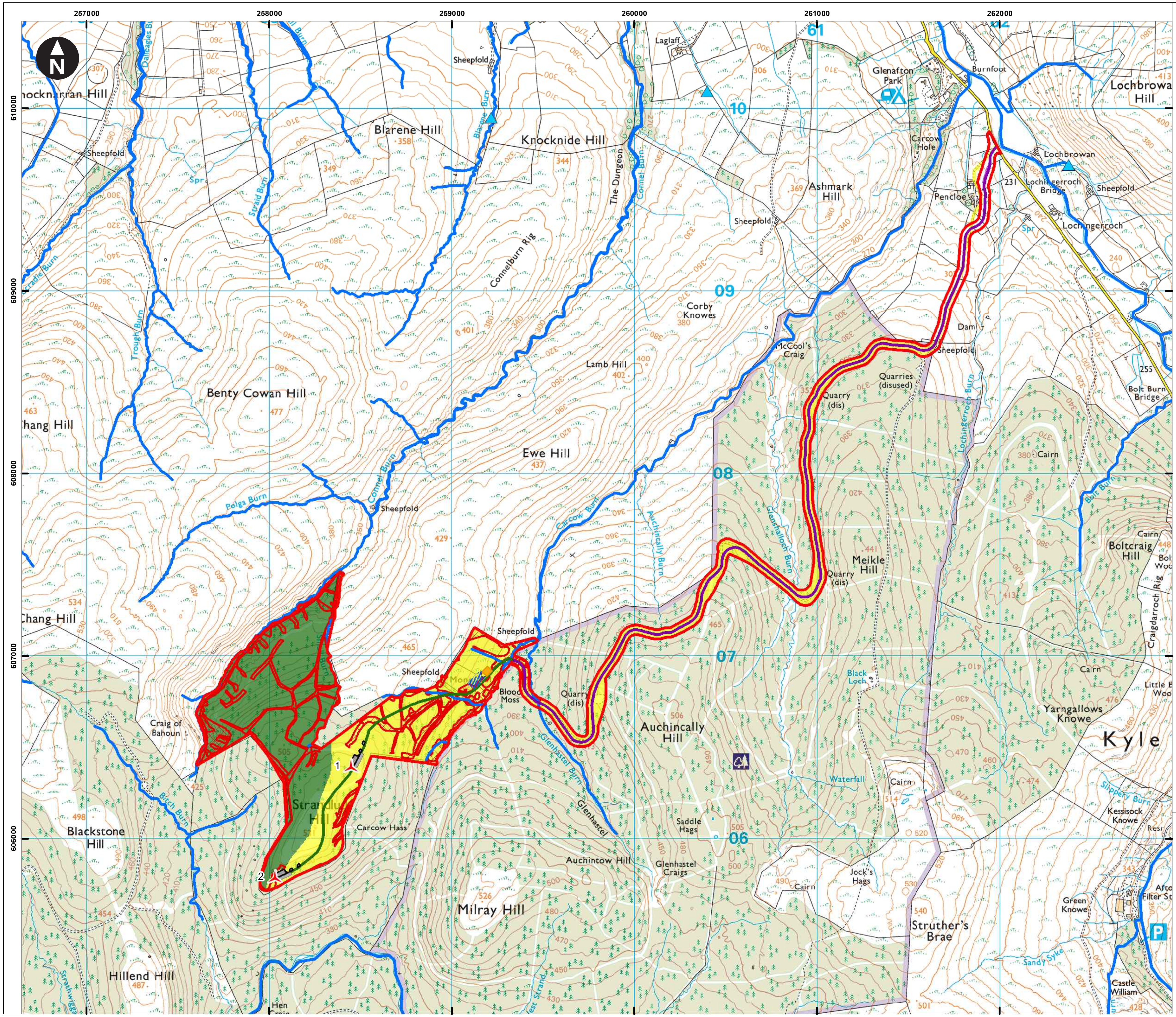

Key

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- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage

Peat Landslide Consequences Scores

- 1 (Very Low)
- 2 (Low)
- 3 (Moderate)
- 4 (High)
- 5 (Very High)
- Private water supplies
- Watercourses
- GWDTEs

Minor infrastructure not shown due to scale

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 km

Scale at A3: 1:20,000

Client

RWE

Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 14.0
Peat Landslide Consequences

August 2023

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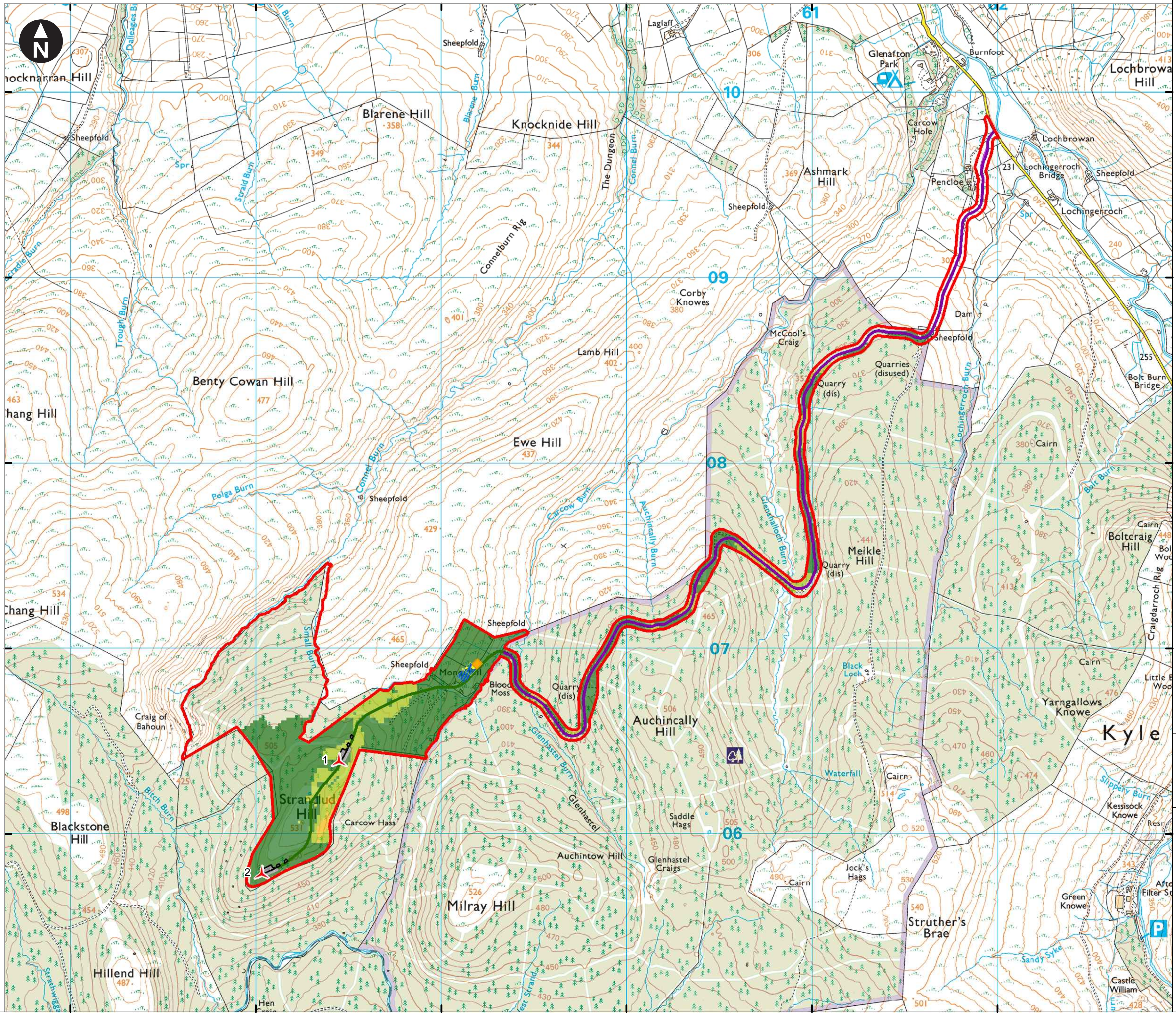

Key

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- Blade laydown area
- Control building and substation compound
- Battery storage compound
- Temporary construction compound

Access Track

- Onsite access tracks
- Pencloe Forest access route
- Layby for temporary turbine delivery storage

Peat Landslide Risk

- 1 (Negligible)
- 2 (Low)
- 3 (Moderate)
- 4 (High)

Minor infrastructure not shown due to scale

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 km

Scale at A3: 1:20,000

Client

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Enoch Hill 2 Wind Farm
Peat Landslide Risk Assessment

Figure 15.0
Peat Landslide Risk

August 2023

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852398-WSPE-FG-R-00008_P01.4

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Appendix B
Project Team

Ben Amaira, BSc (Hons), FGS – author

Ben has over 13 years' experience in the environmental consultancy sector specialising in contaminated land and peat land slide risk assessment. Ben has significant experience of supporting and advising clients in the renewable sector on the peat slide risks and peat management. This includes significant experience in the planning and undertaking of Phase 1 and 2 peat surveys for a range of small and large scale wind farms as well as advising clients on their wind farm layouts. Ben's skills also include the identification and mapping of upland geomorphology including a wide range of incipient and relic peat slide features.

Richard Bagnall, BEng (Hons), CEng, MICE – technical reviewer

Richard is a qualified Civil Engineer with over 13 years postgraduate experience as a geotechnical engineer. He has been involved in a number of high-profile jobs from conception through to construction. His routine work includes the design and management of strategic geotechnical infrastructure including at numerous wind farm sites throughout the United Kingdom. Richard regularly manages Phase 1 and 2 peatland surveys and undertakes peat slide risk assessments for planning applications in accordance with Scottish Government Best Practice including the geomorphological mapping of sites to identify evidence of any relic peat slide features. Additionally, Richard provides design advice on wind farm layouts and micro-siting of turbines to alleviate site constraints prior to design freeze.

Graeme Smart, BEng (Hons), CEng, MICE – technical approver

Graeme is a chartered civil engineer with over 30 years of consultancy experience specialising in geotechnical engineering. Graeme has significant experience across a number of sectors including renewables and has successfully led the Geotechnical Team enabling timely delivery and ensuring technical quality of many peat landslide risk assessments for numerous windfarms across the UK. Due to Graeme's experience in this sector he is often asked to review contractors wind turbine foundation proposals, on behalf of clients, to identify any potential issues with design and/or construction. This frequently necessitates a good understanding of the interaction of construction processes / materials and peat.

Appendix C
Photographs

Plate 1: Looking northwest over a bog pool to the north-northeast of Strandlud Hill

Plate 2: Looking generally north along the northwest slope of Strandlud Hill showing the steeper slopes, dense trees and exposed bedrock.

Plate 3: Looking generally south over an area of rushes to the east of WTG-01.

Plate 4: Looking generally southwest along the main access track to the north of Auchincally Hill

Appendix D
Peat Depth Data

ID	Peat Depth	Easting	Northing
0	0.08	259241.8	606962.8
1	0.15	259227.3	606975.8
2	0.2	259211.2	606977.9
3	0.25	259212.1	606990
4	0.25	259196.6	607004.4
5	0.1	259182.1	607017.3
6	0.05	259183.1	607004
7	0.05	259170.4	607004
8	0.4	259169.7	606990.3
9	0.05	259157.5	606989.6
10	0.1	259154.6	606974.4
11	0.15	259142.9	606960.6
12	0.15	259142	606973.9
13	0.55	259128.2	606959
14	0.3	259128.4	606946.8
15	0.4	259114.2	606945.1
16	0.05	259114.7	606931.7
17	0.4	259101.4	606916.1
18	0.35	259100.1	606930.1
19	0.5	259088.7	606915.6
20	0.3	259100.5	606902
21	0.55	259115.3	606888.3
22	0.1	259130.4	606874.6
23	0.02	259146.4	606862.9
24	0.02	259145.3	606874.6
25	0.02	259158.3	606863.5

ID	Peat Depth	Easting	Northing
26	0.15	259130.7	606888.8
27	0.2	259116.1	606902.7
28	0.3	259115.9	606916.5
29	0.35	259130.4	606903.8
30	0.4	259130	606917.2
31	0.55	259129	606930.7
32	0.3	259142.9	606931.9
33	0.2	259143.1	606945.9
34	0.15	259157.2	606946.5
35	0.1	259156.8	606960.5
36	0.1	259171.1	606960.9
37	0.1	259170.3	606975.1
38	0.15	259184.2	606975.8
39	0.1	259184.1	606989.6
40	0.05	259197.5	606990.1
41	0.2	259198.3	606975.7
42	0.05	259213.2	606962.5
43	0.02	259226.9	606962.9
44	0.01	259241.8	606948.8
45	0.02	259227.7	606948.2
46	0.1	259213.9	606947.7
47	0.05	259228.1	606934.3
48	0.05	259214.2	606933.8
49	0.02	259213.6	606920
50	0.02	259199.2	606947.1
51	0.05	259198.6	606961.6

ID	Peat Depth	Easting	Northing
52	0.05	259185.1	606961
53	0.1	259185.6	606947.2
54	0.05	259200.2	606933.3
55	0.05	259185.2	606933.2
56	0.1	259199.9	606919.3
57	0.1	259171.9	606918.7
58	0.05	259172.1	606931.7
59	0.05	259171.3	606947.2
60	0.02	259158.3	606931.8
61	0.05	259157.8	606918.4
62	0.07	259143.5	606917.2
63	0.05	259144.4	606903.4
64	0.9	259158.5	606903.9
65	0.05	259143.9	606889.2
66	0.02	259158.9	606889.9
67	0.02	259159.6	606875.6
68	0.01	259173.5	606876.2
69	0.01	259186.9	606890.7
70	0.01	259200.9	606905.6
71	0.02	259186.9	606904.9
72	0.03	259186.8	606918.9
73	0.03	259172.9	606904.9
74	0.01	259172.4	606890.5
75	0.01	259147.4	606846.9
76	0.05	259150.8	606836.7
77	0.01	259149.4	606822.2

ID	Peat Depth	Easting	Northing
78	0.01	259164.3	606821.8
79	0.13	259164.1	606807.5
80	0.5	259163.1	606793.4
81	0.08	259148	606796.7
82	0.05	259150	606808.2
83	0.05	259135.8	606807.1
84	0.05	259135.7	606794.5
85	0.02	259136.7	606822.3
86	0.01	259121.1	606818.1
87	0.01	259135.4	606831.9
88	0.05	259121	606831.1
89	0.05	259105.6	606831.7
90	0.05	259119.3	606846.1
91	0.08	259105.6	606846
92	0.05	259119	606860.9
93	0.03	259133.9	606846.7
94	0.02	259133.5	606858.5
95	0.4	258852.4	606759
96	0.25	258592.3	606625.8
97	0.35	258552.8	606599.6
98	0.55	258543.1	606605.6
99	0.45	258556.9	606593.2
100	0.5	258523	606549.7
101	0.45	258509.7	606507.5
102	0.25	258431.8	606392.4
103	0.3	258421.5	606387.9

ID	Peat Depth	Easting	Northing
104	0.4	258441.3	606417.8
105	0.5	258492.8	606456.3
106	0.45	258501.7	606451.9
107	0.45	258498.4	606444.5
108	0.4	258495.3	606437.4
109	0.25	258492.8	606425.7
110	0.4	258479	606395.5
111	0.4	258471.7	606396
112	0.3	258460.4	606398.2
113	0.3	258445.9	606393.3
114	0.25	258446.9	606388.5
115	0.6	258474.6	606355.5
116	0.5	258469	606365.4
117	0.5	258464.2	606374.5
118	0.35	258459	606383.2
119	0.3	258443.5	606382.4
120	0.4	258442.8	606372.6
121	0.4	258440.6	606361.9
122	0.35	258435.2	606353.6
123	0.5	258627.3	606658
124	1	258625	606667.5
125	0.7	258631.7	606651
126	0.7	258676	606673.7
127	0.8	258676.4	606684.1
128	0.8	258672	606692.7
129	0	259285.3	606846.1

ID	Peat Depth	Easting	Northing
130	0.25	258035	605796.2
131	0.2	258039.3	605789.9
132	0.15	258039.3	605789.9
133	0.15	258051.6	605801.2
134	0.15	258042.9	605785.8
135	0.15	258048.9	605783.2
136	0.2	258055	605776.5
137	0.05	258034.5	605776.4
138	0.05	258035.7	605766.4
139	0.1	258037.3	605756.2
140	0.15	258038.2	605746.4
141	0.15	258069.9	605763.7
142	0.15	258062.8	605770.6
143	0.45	258000.8	605757.2
144	0.3	258007.2	605764.4
145	0.3	258013.2	605773.2
146	0.45	258019.9	605781.1
147	0.1	258022.2	605795
148	0.05	258011.7	605793.9
149	0.2	258001.3	605792.7
150	0.25	257984.5	605789.3
151	0.15	257994.4	605789.3
152	0.2	258023.2	605802.9
153	0.2	258014.4	605809.8
154	0.05	258009.2	605815.5
155	0.15	258001.5	605821.3

ID	Peat Depth	Easting	Northing
156	0.1	257994.4	605827.4
157	0.1	258026.2	605787.8
158	0.15	258034.1	605784.9
159	0.05	258032.7	605805.8
160	0.25	258028.7	605816.1
161	0.15	258028	605826.5
162	0.15	258027.6	605837
163	0.1	258026.6	605845.6
164	0.1	258039.6	605804.2
165	0.05	258044.6	605810.2
166	0.05	258059.6	605809.2
167	0.05	258050.6	605819.9
168	0.05	258058.6	605828
169	0.1	258064.2	605833.9
170	0.1	258068.4	605814.6
171	0.05	258077.4	605818.8
172	0.05	258086.6	605821.7
173	0.3	258212.4	605924.3
174	0.3	258256.5	605936.6
175	0.45	258262.7	605928.8
176	0.5	258293.3	605971
177	0.3	258284.7	605976.6
178	0.35	258275.3	605979.7
179	0.6	258285.5	606024.7
180	0.75	258296.4	606023.5
181	0.45	258306.9	606022.2

ID	Peat Depth	Easting	Northing
182	0.25	258305.4	606073.4
183	0.35	258294.8	606072.2
184	0.1	258286.5	606071.9
185	0.25	258303.9	606122.5
186	0.2	258293.9	606123.3
187	0.15	258284	606123.6
188	0.55	258299.1	606171.1
189	0.35	258288.9	606173.8
190	0.6	258308.1	606168.6
191	0.8	258318	606220.3
192	0.8	258326.5	606214.8
193	0.3	258349.1	606261.9
194	0.35	258354.2	606256
195	1.35	258360.3	606248.3
196	0.95	258393.8	606285.1
197	0.85	258387.5	606293.3
198	0.15	258414.8	606383.1
199	0.25	258405.4	606378.4
200	1.05	258401.6	606416.5
201	0.85	258411.5	606413.6
202	0.85	258420.2	606411.5
203	0.55	258430.4	606408
204	0.5	258439	606405.1
205	0.25	258444.8	606411.1
206	0.45	258449.4	606401.6
207	0.3	258454.5	606392.8

ID	Peat Depth	Easting	Northing
208	0.2	258458.1	606407.2
209	0.35	258452.7	606411.3
210	0.8	258466.4	606410.6
211	0.6	258474.9	606415.8
212	0.7	258479.1	606409.2
213	0.65	258497.4	606386
214	0.35	258488.8	606387.6
215	0.55	258484.5	606420.1
216	0.35	258491.1	606428.8
217	0.25	258455	606420.4
218	0.95	258434.2	606428.1
219	1.2	258427.6	606444.7
220	1.1	258476.2	606455.3
221	0.9	258470.1	606444.2
222	0.85	258461.6	606439
223	0.7	258459.5	606429.5
224	0.95	258487.8	606464.7
225	0.7	258518.6	606507.2
226	0.85	258526.4	606501.1
227	0.75	258532.8	606547.7
228	0.8	258541.2	606542.5
229	0.3	258580.2	606641.7
230	0.25	258585.8	606632.6
231	0.95	258601.1	606657.1
232	0.85	258608.3	606650
233	0.65	258616.6	606642.4

ID	Peat Depth	Easting	Northing
234	0.35	258723.5	606695
235	0.4	258716.6	606704.3
236	0.25	258713.1	606713.7
237	0.6	258759.9	606713.5
238	0.5	258757.3	606723
239	0.75	258754.8	606733.2
240	0.8	258801	606754
241	0.65	258804.3	606744.4
242	0.55	258806.2	606733.9
243	0.9	258849.5	606770.5
244	0.55	258854.1	606748.7
245	0	258056.9	605857
246	0.2	258036.7	605856.3
247	0	258028.9	605880.3
248	0	258018.7	605855.7
249	0.2	258022.1	605832.1
250	0	258070	605839.8
251	0	258087	605838.8
252	0	258061.3	605818.7
253	0	258082.9	605868
254	0	258077.7	605893.6
255	0	258111.2	605896.6
256	0	258126.6	605920.2
257	0.4	258161.1	605958.3
258	0	258194.6	605996.5
259	0.2	258222.5	606038.5

ID	Peat Depth	Easting	Northing
260	0	258227.9	606075.5
261	0.4	258260.9	606076.9
262	0	258298.7	606081.8
263	0	258281.1	606097.3
264	0	258244.3	606096.5
265	0	258260.2	606116.1
266	0	258241.8	606130.9
267	0.2	258224.5	606147.2
268	0.2	258257.4	606149.4
269	0.2	258275	606134.3
270	0	258295.9	606115.4
271	0	258293.8	606151.1
272	0.7	258323.6	606152.4
273	0.3	258328.7	606150
274	0.6	258317	606157
275	0.7	258346	606194.3
276	0.5	258353.4	606195
277	0.3	258334	606190.4
278	1.2	258370.1	606246.1
279	0.9	258373.1	606239.6
280	1.1	258360.1	606252.2
281	0.6	258401.7	606271.9
282	0.2	258404.2	606264.9
283	0.45	258443.3	606296.6
284	1	258473.1	606324.3
285	1.2	258465.6	606342.8

ID	Peat Depth	Easting	Northing
286	0.9	258459.8	606344.7
287	0.3	258472	606343
288	0.9	258477.4	606349.4
289	1.8	258500.6	606340.7
290	0.9	258512.2	606364
291	0.4	258489.2	606367.2
292	0.6	258518.7	606384.8
293	0.2	258492.4	606395.5
294	0.4	258483	606398.7
295	0.6	258484.4	606412
296	0.4	258470.7	606410
297	0.5	258454.1	606403
298	0.3	258438.9	606393.3
299	0.6	258440.1	606439.2
300	0.9	258431.1	606438.4
301	0.9	258444.3	606448.8
302	0	258450.3	606530.1
303	0	258466.2	606573.3
304	0.2	258499.9	606610.9
305	0.7	258537.2	606642.9
306	0.4	258532	606651.9
307	0.9	258542.7	606636.2
308	0.45	258585.9	606640.9
309	0.4	258635.2	606620.2
310	0.6	258678.1	606595.8
311	0.5	258675.7	606588.5

ID	Peat Depth	Easting	Northing
312	0.7	258755.8	606635.9
313	0.2	258760.6	606630.8
314	0.4	258793	606669
315	0.4	258835.3	606697.9
316	0.2	258864.9	606726.4
317	0	258914.2	606760.4
318	0	258949	606782.9
319	0.2	258997.9	606788.6
320	0	259050.6	606792.4
321	0	259101.7	606799.8
322	0	259120.6	606807.9
323	0	259142.1	606804
324	0.2	259148.7	606781.8
325	0.3	259177.3	606808.9
326	0	259157.9	606813.7
327	0.3	259138.9	606827.8
328	0.4	259172.5	606868.4
329	0.3	259206.3	606898.6
330	0	259210.3	606913.6
331	0	259207.5	606926.9
332	0.3	259216	606931.9
333	0.2	259217.3	606940.2
334	0.2	259233	606937.2
335	0	259240.9	606940.5
336	0.3	259282.3	606968.5
337	0	259330.3	606982.5

ID	Peat Depth	Easting	Northing
338	1.3	258463.8	606343.3
339	0.7	258347.4	606193.2
340	0.9	258513.5	606363.7
341	0.7	258542.7	606642.2
342	0	259383.8	606949.5
343	0	259396.8	606919.4
344	0	259410	606870.3
345	0	259433.1	606774.4
346	0	259467.4	606750.8
347	1.5	259515	606720.4
348	1.7	259498.9	606711.8
349	1.6	259516.2	606730.7
350	0	259586.5	606659.7
351	0.4	259616.2	606618.7
352	0	259646	606579.9
353	3	259734.3	606539.9
354	1.7	259725.3	606524.9
355	1.9	259724.1	606548.2
356	0	259778.3	606600.9
357	0	259774.2	606617.9
358	0	259771.4	606667.5
359	0	259765.9	606719.8
360	0	259778.1	606778
361	0	259805.6	606837.7
362	0.3	259817.8	606880.5
363	0.3	259872	606933.9

ID	Peat Depth	Easting	Northing
364	0	259888.4	606993
365	0.4	259911.4	607005.7
366	0	260069.5	607127.4
367	0.5	260135.2	607131
368	0	260257.1	607164.3
369	0	260530.2	607447.9
370	0	260479.8	607564.5
371	0	261040.6	607423.8
372	0	260998.8	607644.8
373	0	261538.9	608695
374	0	261651.7	608709.1
375	0.37	258474.2	606396.4
376	0.32	258373.7	606393
377	0.3	258278.7	606410.1
378	0.61	258189.3	606391.9
379	1.08	258179.9	606296.5
380	0.76	258271.7	606286.1
381	0.21	258378.5	606276.4
382	0.83	258480.8	606291.7
383	2	258433.5	606198.2
384	0.1	258329.3	606206.4
385	0.96	258229	606220.7
386	0.14	258188.8	606134.1
387	0.21	258286.7	606107.9
388	0.21	258276.3	606009.4
389	0	258173.3	606009.8

ID	Peat Depth	Easting	Northing
390	0.37	258178.6	605936.1
391	0.07	258262	605953.4
392	1.21	258289.3	606221.1
393	0	259320.9	606984.6
394	0.35	259417.6	607081.4
395	0	259220.3	607084.1
396	0.4	259119.6	607086.4
397	0.4	259119.6	606979
398	0.35	259220.3	606985.8
399	0.4	259213.6	606889.4
400	0.85	259116.9	606884.1
401	0.4	259025.2	606883.5
402	0.3	259023.4	606983.2
403	0	258919.5	606787.9
404	0.7	258818.8	606785.7
405	0.9	258723.9	606777
406	0.3	259020.5	606781.1
407	0	259113.3	606778.4
408	0	259021.5	606688.3
409	0.35	258931.7	606683.9
410	0	258917.8	606587.1
411	0	258917.9	606489.4
412	0	258821.2	606485.4
413	0.25	258825.9	606579
414	0.6	258816.8	606686.6
415	0.6	258724.9	606686.1

ID	Peat Depth	Easting	Northing
416	0	258718.7	606588.6
417	0.2	258623.1	606585.3
418	1	258622.1	606686.8
419	1.2	258530.6	606663.7
420	0.5	258519.7	606594.5
421	0	258422.9	606574.6
422	0	258420.6	606484.8
423	0.35	258318.5	606483.4
424	0.85	258555.9	606491.4
425	0	258621.9	606481.8
426	0.4	258724.9	606464.4
427	0.07	258226.6	606483.4
428	0.02	258125.9	606384.2
429	0.8	257987.5	606459.2
430	0.3	257912	606556.5
431	0.95	258523.3	606375
432	0.03	258278.4	606078.5
433	0.1	258280.6	606128.6
434	0.1	258315.8	606076.3
435	0.5	258279.7	606024.4
436	0	258116.9	605881.6
437	0	258083.7	605849.9
438	0.05	258059.7	605801.5
439	0.1	258029.8	605777.3
440	0.07	257975.7	605702.9
441	0.7	258230.1	606063.2

ID	Peat Depth	Easting	Northing
442	0	259411.8	606814.2
443	0.76	259396	606810.6
444	0.45	259556.5	606703.5
445	1.15	259548.2	606688.8
446	0.97	259682.7	606550.1
447	0.1	259670	606538
448	0	259759.6	606536.1
449	0	259774.7	606744.7
450	0	259761.2	606747
451	0.39	259834.1	606932.9
452	0.87	259846.9	606924.4
453	0.38	259933.7	607106
454	0.39	259950.3	607097.2
455	0.1	260129.3	607134.7
456	0.8	260134.7	607111.8
457	0.39	260308.4	607181.6
458	1.1	260303.6	607191.8
459	0.1	260374.3	607367.8
460	0.57	260389.5	607361.7
461	0.4	260488.8	607531.5
462	0.6	260473.9	607531.2
463	0.6	260607.9	607571
464	1.25	260749.3	607442.5
465	1.77	260908.9	607300.6
466	2.51	260917.8	607319.7
467	0	261010.8	607423.9

ID	Peat Depth	Easting	Northing
468	0	261021.2	607419.3
469	0.35	260943.1	608005.8
470	0.75	260953.9	608203.3
471	0.2	260973.8	608408.5
472	0	260984.6	608402.6
473	0.7	261102.5	608547.7
474	0	261284.5	608642.6
475	0.15	261455.4	608710.2
476	0.2	261452.1	608694.4
477	0.2	261624.3	608696.1
478	0.23	261629.5	608685.5

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