Statkraft

Coille Beith Wind Farm

Technical Appendix 8.4: Peat Landslide Hazard and Risk Assessment (PLHRA)

June 2025

Contents

1. Introduction

1.1 Background

1.1.1 Coille Beith Wind Farm Limited (the Applicant) is seeking consent under Section 36 of the Electricity Act 1989 to construct and operate an onshore wind farm of up to 11 turbines, near Lairg, The Highlands, Scotland. The Site for the Proposed Development lies approximately 18 km to the southwest of Lairg and 20 km to the northwest of Bonar Bridge and is approximately 13 km^2 (c. 1,306 ha) in area (see **Figure 2.**1, EIA Report Volume 3a).

1.1.2 The Scottish Government Best Practice Guidance (BPG) provides a screening tool to determine whether a peat landslide hazard and risk assessment (PLHRA) is required (Scottish Government, 2017). This is in the form of a flowchart and indicates that where blanket peat is present, slopes exceed 2°, and proposed infrastructure is located on peat, a PLHRA should be prepared. These conditions exist at the Proposed Development site and therefore a PLHRA is required.

1.2 Scope of Work

1.2.1 The scope of the PLHRA is as follows:

- Characterise the peatland geomorphology of the Site to determine whether prior incidences of instability have occurred and whether contributory factors that might lead to instability in the future are present across the Site;
- Determine the likelihood of a future peat landslide under natural conditions and in association with construction activities associated with the Proposed Development;
- Identify potential receptors that might be affected by peat landslides, should they occur, and quantify the associated risks; and
- Provide appropriate mitigation and control measures to reduce risks to acceptable levels such that the Proposed Development is developed safely and with minimal risks to the environment.

1.2.2 The contents of this PLHRA have been prepared in accordance with the BPG, noting that the guidance *"should not be taken as prescriptive or used as a substitute for the developer's [consultant's] preferred methodology"* (Scottish Government, 2017). The first edition of the Scottish Government Best Practice Guidance (BPG) was issued in 2007 and provided an outline of expectations for approaches to be taken in assessing peat landslide risks on wind farm sites. After 10 years of practice and industry experience, the BPG was reissued in 2017, though without fundamental changes to the core expectations. A key change was to provide clearer steer on the format and outcome of reviews undertaken by the Energy Consents Unit (ECU) checking authority and related expectations of report revisions, should they be required.

1.2.3 In section 4.1 of the BPG, the key elements of a PLHRA are highlighted, as follows (Scottish Government, 2017):

- An assessment of the character of the peatland within the application boundary including thickness and extent of peat, and a demonstrable understanding of site hydrology and geomorphology;
- An assessment of evidence for past landslide activity and present-day instability e.g. pre-failure indicators;
- A qualitative or quantitative assessment of the potential for or likelihood of future peat landslide activity (or a landslide susceptibility or hazard assessment);
- Identification of receptors (e.g. habitats, watercourses, infrastructure, human life) exposed to peat landslide hazards; and
- A site-wide qualitative or quantitative risk assessment that considers the potential consequences of peat landslides for the identified receptors.

1.2.4 The spatial scope of this PLHRA is limited to the main Site and western access track option. The eastern access track option is primarily an upgrade to existing track and lacks peat depth data to support an assessment. A separate PLHRA has been undertaken for the neighbouring consented Strath Oykel Wind Farm by a third party and has found Low or Negligible risks for the route. This route is the same as the proposed West access option for the Proposed Development and therefore it is anticipated that risks would be acceptable for this option.

1.3 Technical Appendix Structure

1.3.1 This following sections in this Technical Appendix are structured as follows:

- **Section 2** gives context to the landslide risk assessment methodology through a literature-based account of peat landslide types and contributory factors, including review of any published or anecdotal information available concerning previous instability at or adjacent to the site;
- **Section 3** provides a Site description based on desk study and site observations, including consideration of aerial or satellite imagery, digital elevation data, geology, and peat depth data;
- **Section 4** describes the approach to and results of an assessment of peat landslide likelihood under both natural conditions and in association with construction of the Proposed Development;
- **Section 5** describes the approach to and results of a consequence assessment that determines potential impacts on-site receptors and the associated calculated risks; and
- **Section 6** provides mitigation and control measures to reduce or minimise these risks prior to, during, and after construction.

1.3.2 Assessments within the PLHRA have been undertaken alongside assessments for the Peat Management Plan (see **Technical Appendix 8.3**, EIA Report Volume 4) and have been informed by results from the Peat Survey (see **Technical Appendix 8.2**, EIA Report Volume 4). Where relevant information is available elsewhere in the EIA Report, this is referenced in the text rather than repeated in this report.

1.3.3 This Technical Appendix is supported by the following figures in **Annex A**:

- Figure 8.4.1: Elevation;
- Figure 8.4.2: Slope;
- Figure 8.4.3: Geology;
- Figure 8.4.4: Geomorphology, hydrology and land use;
- Figure 8.4.5a: Peat Depth – without probes;
- Figure 8.4.5b: Peat Depth – with probes;
- Figure 8.4.6: Factor of Safety;
- Figure 8.4.7: Contributory Factors;
- Figure 8.4.8: Landslide Likelihood;
- Figure 8.4.9: Source and runout zones; and
- Figure 8.4.10: Calculated risk.

1.4 Approach to Assessing Peat Instability

1.4.1 The approach to assessing peat instability has been through both a qualitative contributory factor-based approach and via a more conventional stability analysis (through limit equilibrium or Factor of Safety (FoS) analysis). The advantage of the former is that many observed relationships between reported peat landslides and ground conditions can be considered together where a FoS is limited to consideration of a limited number of geotechnical parameters. The disadvantage is that the outputs of such an approach are better at illustrating relative variability in landslide susceptibility across a site rather than absolute likelihood.

1.4.2 The advantage of the FoS approach is that clear thresholds between stability and instability can be defined and modelled numerically. However, in reality, there is considerable uncertainty in input parameters and it is a generally held view that the geomechanical basis for stability analysis in peat is limited given the nature of peat as an organic, rather than mineral soil.

1.4.3 To reflect these limitations, both approaches are adopted and outputs from each approach integrated in the assessment of landslide likelihood. **Plate 1.2** shows the approach.

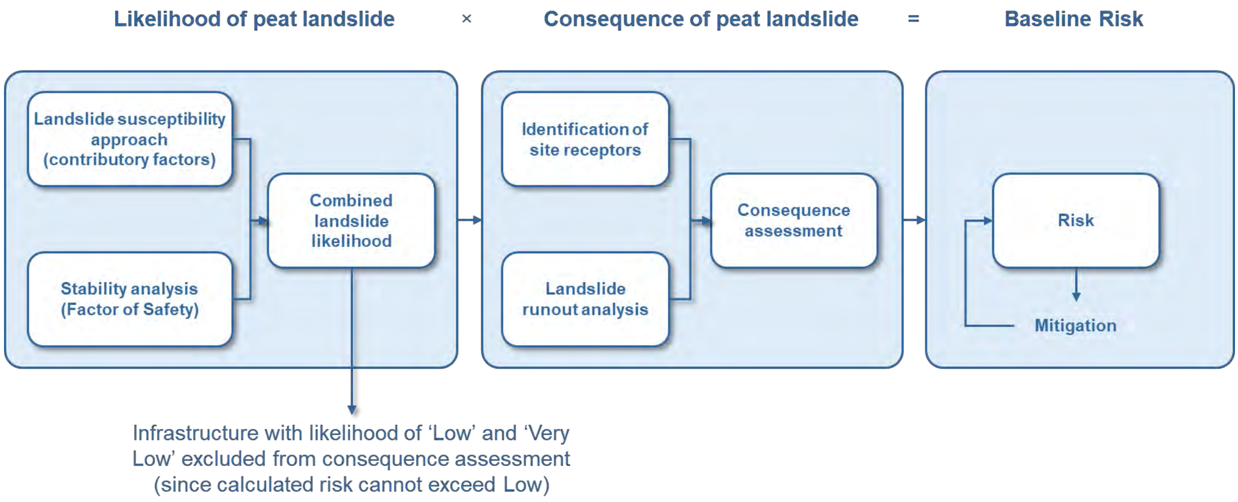

Plate 1.2: Risk Assessment Approach

1.5 Team Competencies

1.5.1 This PLHRA has been undertaken by a chartered geologist with 27+ years' experience of mapping and interpreting peatland terrains and peat instability features. Geomorphological walkover survey and peat depth probing was undertaken by Fluid Environmental Consulting, a highly experienced peatland survey team, and site observations and photographs were made available from these surveys to the PLHRA team.

2. Background to Peat Instability

2.1 Peat Instability in the UK and Ireland

2.1.1 This section reviews published literature to highlight commonly identified landscape features associated with recorded peat landslides in the UK and Ireland. This review forms the basis for identifying similar features at the Proposed Development and using them to understand the susceptibility of the site to naturally occurring and human induced peat landslides.

2.1.2 Peat instability, or peat landslides, are a widely documented but relatively rare mechanism of peatland degradation that may result in damage to peatland habitats, potential losses in biodiversity and depletion of peatland carbon stores (Evans & Warburton, 2007). Public awareness of peat landslide hazards increased significantly following three major peat landslide events in 2003, two of which had natural causes and one occurring in association with a wind farm.

2.1.3 On 19th September 2003, multiple peat landslide events occurred in Pollatomish (Co. Mayo, Ireland; Creighton and Verbruggen, 2003) and in Channerwick in the Southern Shetland Islands (Mills et al, 2007). Both events occurred in response to intense rainfall, possibly as part of the same large-scale weather system moving northeast from Ireland across Scotland. The former event damaged several houses, a main road and washed away part of a graveyard. Some of the landslides were sourced from areas of turbary (peat cutting) with slabs of peat detaching along the cuttings. The landslides in Channerwick blocked the main road to the airport and narrowly missed traffic using the road. Watercourses were inundated with peat, killing fish inland and shellfish offshore (Henderson, 2005).

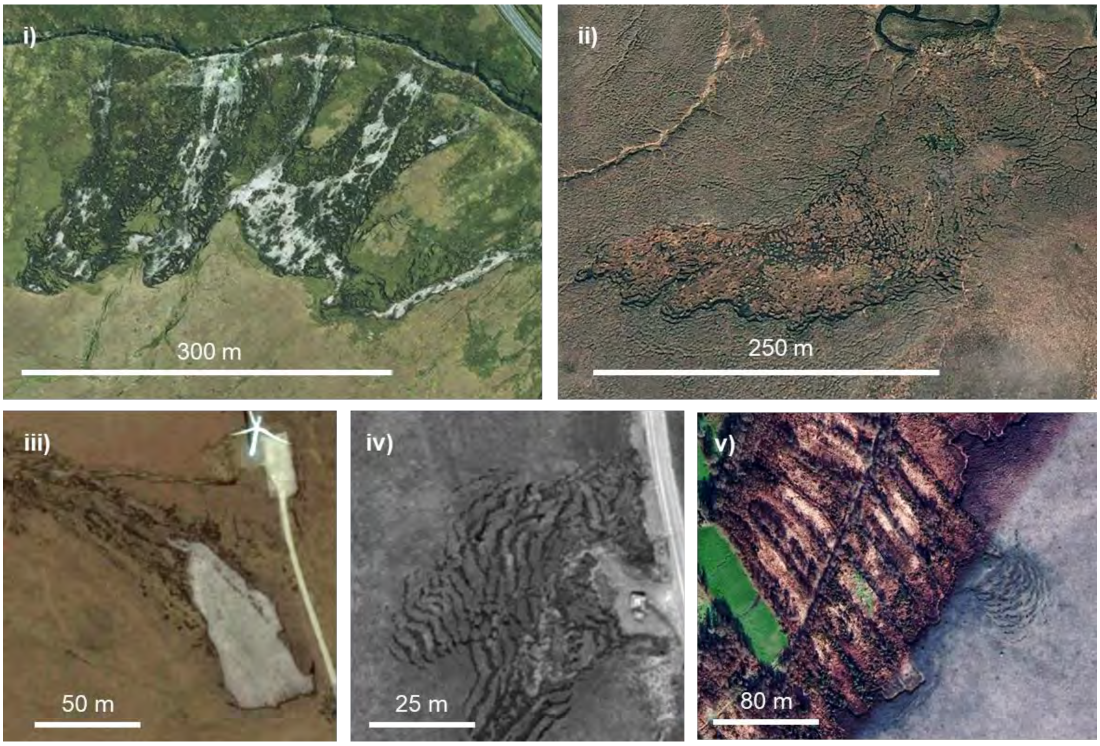

Plate 2.1: Characteristic Peat Landslide Types in UK and Irish Peat Uplands

Notes: i) multiple peat slides with displaced slabs and exposed substrate, ii) retrogressive bog burst with peat retained within the failed area; Bottom row - failures possibly induced by human activity: iii) peat slide adjacent to turbine foundation, iv) spreading around foundation, v) spreading upslope of cutting.

2.1.4 In October 2003, a peat failure occurred on an afforested wind farm site in Derrybrien, County Galway, Ireland, causing disruption to the site and large-scale fish kill in the adjoining watercourses (Lindsay and Bragg, 2004).

2.1.5 The Derrybrien event triggered interest in the influence of wind farm construction and operation on peatlands, particularly in relation to potential risks arising from construction induced peat instability. In 2007, the (then) Scottish Executive published guidelines on peat landslide hazard and risk assessment in support of planning applications for wind farms on peatland sites. While the production of PLHRA reports is required for all Section 36 energy projects on peat, they are now also regarded as best practice for smaller wind farm applications. The guidance was updated in 2017 (Scottish Government, 2017).

2.1.6 Since then, a number of peat landslide events have occurred both naturally and in association with wind farms (see **Plate 2.1**). In the case of wind farm sites, these have rarely been reported, however landslide scars of varying age are visible in association with wind farm infrastructure on Corry Mountain, Co. Leitrim, at Sonnagh Old Wind Farm, Co. Galway (near Derrybrien; Cullen, 2011), and at Corkey Wind Farm, Co. Antrim. In December 2016, a plant operator was killed during excavation works in peat at the Derrysallagh wind farm site in Co. Leitrim (Flaherty, 2016) on a plateau in which several published examples of instability had been previously reported. A peat landslide was also reported in 2015 near the site of a proposed road for the Viking Wind Farm on Shetland (The Shetland Times, 2015) though this was not in association with construction works.

2.1.7 Other recent natural events include another failure in Galway at Clifden in 2016 (Irish News, 2016), Cushendall, Co. Antrim (BBC, 2014), in the Glenelly Valley, Co. Tyrone in 2017 (BBC, 2018), Drumkeeran in Co. Leitrim in July 2020 (Irish Mirror, 2020) and Benbrack in Co Cavan in July 2021 (The Anglo-Celt, 2021). Noticeably, the vast majority of reported failures since 2003 have occurred in Ireland and Northern Ireland, with one reported Scottish example occurring on the Shetland Islands (Mid Kame), an area previously associated with peat instability. Two occurrences of instability in association with construction works on the Viking Wind Farm have been reported (July 2022 and May 2024), though in both cases, these have involved failure of peat or mineral spoil at track margins rather than the triggering of a new 'peat slide' by groundworks.

2.2 Types of Peat Instability

2.2.1 Peat instability is manifested in a number of ways (Dykes and Warburton, 2007) all of which can potentially be observed on-site either through site walkover or remotely from high resolution aerial photography:

- **minor instability:** localised and small-scale features that are not generally precursors to major slope failure and including gully sidewall collapses, pipe ceiling collapses, minor slumping along diffuse drainage pathways (e.g. along flushes); indicators of incipient instability including development of tension cracks, tears in the acrotelm (upper vegetation mat), compression ridges, or bulges / thrusts (Scottish Government, 2017); these latter features may be warning signs of larger scale major instability (such as landsliding) or may simply represent a longer term response of the hillslope to drainage and gravity, i.e. creep.
- **major instability:** comprising various forms of peat landslide, ranging from small scale collapse and outflow of peat filled drainage lines/gullies (occupying a few-10s cubic metres), to medium scale peaty-debris slides in organic soils (10s to 100s cubic metres) to large scale peat slides and bog bursts (1,000s to 100,000s cubic metres).

2.2.2 Evans and Warburton (2007) present useful contextual data in a series of charts for two types of large-scale peat instability - peat slides and bog bursts. The data are based on a peat landslide database compiled by Mills (2002) which collates site information for reported peat failures in the UK and Ireland. Separately, Dykes and Warburton (2007) provide a more detailed classification scheme for landslides in peat based on the type of peat deposit (raised bog, blanket bog, or fen bog), location of the failure shear surface or zone (within the peat, at the peat-substrate interface, or below), indicative failure volumes, estimated velocity and residual morphology (or features) left after occurrence.

2.2.3 For the purposes of this assessment, landslide classification is simplified and split into three main types, typical examples of which are shown in **Plate 2.1**. Dimensions, slope angles and peat depths are drawn from charts presented in Evans and Warburton (2007). The term "peat slide" is used to refer to large-scale (typically less than 10,000 of cubic metres) landslides in which failure initiates as large rafts of material which subsequently break down into smaller blocks and slurry. Peat slides occur 'top-down' from the point of initiation on a slope in thinner peats (between 0.5 m and 1.5 m) and on moderate slope angles (typically 5°-15°, see **Plate 2.2**).

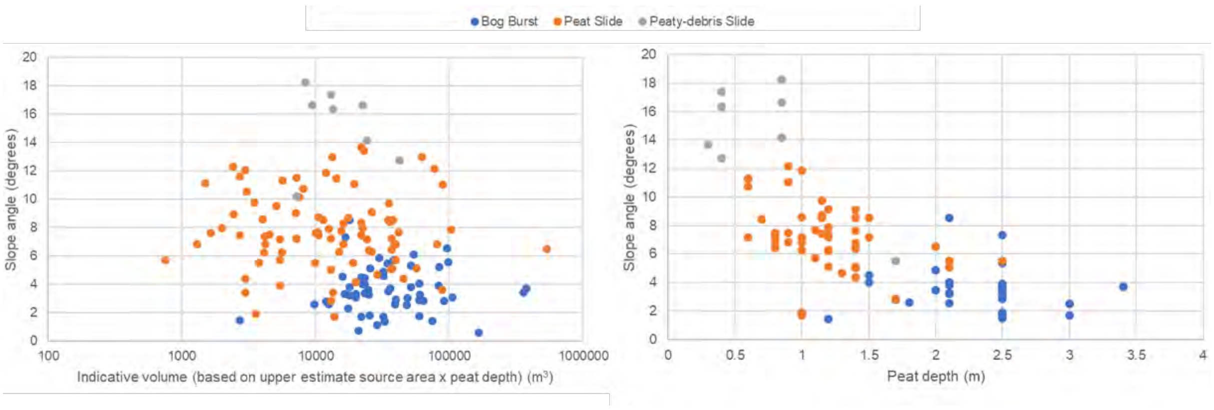

Plate 2.2 Reported Slope Angles and Peat Depths Associated with Peat Slides and Bog Bursts (from literature review of locations, depths and slope angles, after Mills, 2002)

2.2.4 The term "bog burst" is used to refer to very large-scale (usually greater than 10,000 of cubic metres) spreading failures in which the landslide retrogresses (cuts) upslope from the point of failure while flowing downslope. Peat is typically deeper (greater than 1.0 m and up to 10 m) and more amorphous than sites experiencing peat slides, with shallower slope angles (typically 2°-5°). Much of the peat displaced during the event may remain within the initial failure zone. Bog bursts are rarely (if ever) reported in Scotland other than in the Western Isles (e.g. Bowes, 1960).

2.2.5 The term "peaty soil slide" is used to refer to small-scale (1,000s of cubic metres) slab-like slides in organic soils (i.e. they are <0.5 m thick). These are similar to peat slides in form, but far smaller and occur commonly in UK uplands across a range of slope angles (Dykes and Warburton, 2007). Their small size means that they often do not affect watercourses and their effect on habitats is minimal.

2.2.6 Few if any spreading failures in peat (i.e. bog bursts) have been reported in Scotland, with only one or two unpublished examples in evidence on the Isle of Lewis and Caithness. There are no published failures or news reports of landslides in proximity to the Proposed Development and no landowner reports of instability within the Site.

2.3 Factors Contributing to Peat Instability

2.3.1 Peat landslides are caused by a combination of factors – triggering factors and reconditioning factors (Dykes and Warburton, 2007; Scottish Government, 2017). Triggering factors have an immediate or rapid effect on the stability of a peat deposit whereas preconditioning factors influence peat stability over a much longer period. Only some of these factors can be addressed by site characterisation.

2.3.2 Preconditioning factors may influence peat stability over long periods of time (years to hundreds of years), and include:

- Impeded drainage caused by a peat layer overlying an impervious clay or mineral base (hydrological discontinuity).
- A convex slope or a slope with a break of slope at its head (concentration of subsurface flow).
- Proximity to local drainage, either from flushes, pipes or streams (supply of water).
- Connectivity between surface drainage and the peat/impervious interface (mechanism for generation of excess pore pressures).
- Artificially cut transverse drainage ditches, or grips (elevating pore water pressures in the basal peat-mineral matrix between cuts, and causing fragmentation of the peat mass).
- Increase in mass of the peat slope through peat formation, increases in water content or afforestation.
- Reduction in shear strength of peat or substrate from changes in physical structure caused by progressive creep and vertical fracturing (tension cracking or desiccation cracking), chemical or physical weathering or clay dispersal in the substrate.
- Loss of surface vegetation and associated tensile strength (e.g. by burning or pollution induced vegetation change).
- Increase in buoyancy of the peat slope through formation of sub-surface pools or water-filled pipe networks or wetting up of desiccated areas.
- Afforestation of peat areas, reducing water held in the peat body, and increasing potential for formation of desiccation cracks which are exploited by rainfall on forest harvesting.

2.3.3 Triggering factors are typically of short duration (minutes to hours) and any individual trigger event can be considered as the 'straw that broke the camel's back':

- Intense rainfall or snowmelt causing high pore pressures along pre-existing or potential rupture surfaces (e.g. between the peat and substrate).
- Rapid ground accelerations (e.g. from earthquakes or blasting).
- Unloading of the peat mass by fluvial incision or by artificial excavations (e.g. cutting).
- Focusing of drainage in a susceptible part of a slope by alterations to natural drainage patterns (e.g. by pipe blocking or drainage diversion).
- Loading by plant, spoil or infrastructure.

2.3.4 External environmental triggers such as rainfall and snowmelt cannot be mitigated against, though they can be managed (e.g. by limiting construction activities during periods of intense rain). Unloading of the peat mass by excavation, loading by plant and focusing of drainage can be managed by careful design, site specific stability analyses, informed working practices and monitoring.

2.4 Consequences of Peat Instability

2.4.1 Both peat slides and bog bursts have the potential to be large in scale, disrupting extensive areas of blanket bog and with the potential to discharge large volumes of material into watercourses.

2.4.2 A key part of the risk assessment process is to identify the potential scale of peat instability should it occur and identify the receptors of the consequences. Potential sensitive receptors of peat failure are:

- The development infrastructure and turbines (damage to turbines, tracks, substation, etc).
- Site workers and plant (risk of injury / death or damage to plant).
- Wildlife (disruption of habitat) and aquatic fauna.
- Watercourses and lochs (particularly associated with public water supply).
- Site drainage (blocked drains / ditches leading to localised flooding / erosion); and
- Visual amenity (scarring of landscape).

2.4.3 While peat failures may cause visual scarring of the peat landscape, most peat failures revegetate fully within 50 to 100 years and are often difficult to identify on the ground after this period of time (Feldmeyer-Christe and Küchler, 2002; Mills, 2002). Typically, it is short-term (seasonal) effects on watercourses that are the primary concern or impacts on public water supply.

3. Baseline Conditions

3.1 Topography

3.1.1 The Site is distributed across a series of north facing slopes that form a basin facing towards Strath Oykel and the River Oykel north of the Site. Beinn Ulbhaidh (494 m AOD) is the highest local summit, outside the Site to the southeast. The southern Site boundary runs along a ridge crest from west to east from Cnoc nan Con (335 m AOD) via Cnoc nan Caorach (387 m AOD) to Carn na Bo Maoile (387 m AOD) and then an unnamed ridge (438 m AOD) to the north of Beinn Ulbahidh (**Figure 8.4.1**).

3.1.2 The western edge of the basin is defined by a ridge comprising a series of unnamed minor summits below Cnoc nan Con, the first of which (308 m AOD) bounds Loch Phail, with subsequent summits (307 m AOD, 279 m AOD and 250 m AOD) running towards Beinn Chreagach (222 m AOD) in the north of the Site.

3.1.3 Key geographical features are shown on **Plate 3.1**.

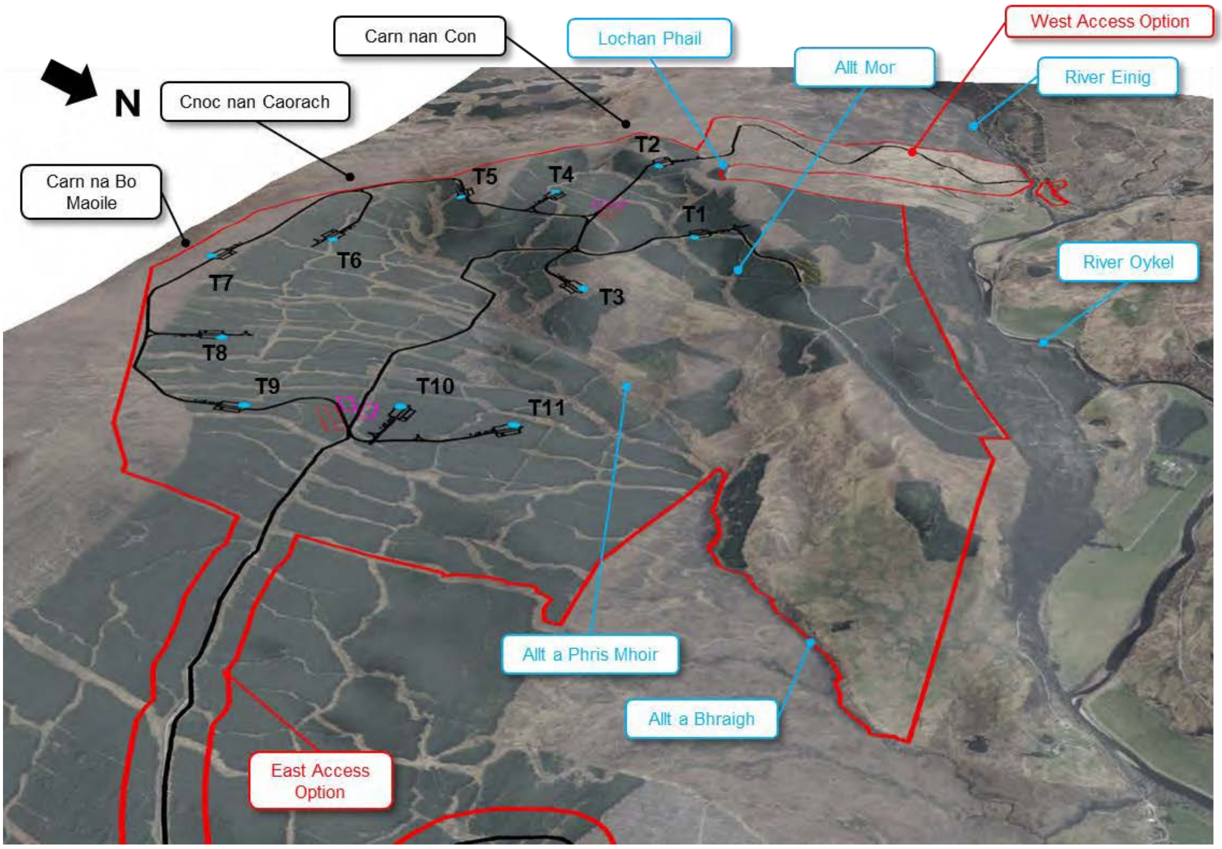

Plate 3.1: Perspective View of Site Showing Key Geographical Features

3.1.4 Slopes fall fairly continuously from the southern ridge line to the north, dissected by numerous largely parallel watercourse that are confluent in a smaller number of main (named tributaries to the River Oykel). Slope angles are shown on **Figure 8.4.2** generated from an OS Terrain 5 DTM. Slopes are locally moderate (5-10°) to steep (>10°) along parts of the southern ridge, along watercourse margines and in the north of the Site, and western access route option. There are relatively limited areas where slope angles are less than 3°, which is generally regarded as the limit for the specification of floating track.

3.1.5 The OS Terrain 5 DTM is a triangulated irregular network (TIN) bare earth model with strong artefact from the irregular data points used to compile it and the algorithm used to remove forestry. Changes in slope angle will be more subtle on the ground than shown on **Figure 8.4.2**, and this has the potential to both over and under-represent slope angles at most locations under the forestry.

3.2 Geology

3.2.1 **Figure 8.4.3** shows the solid geology of the site mapped from 1:50,000 scale publicly available BGS digital data and indicates the Site to be almost entirely underlain by Altnaharra psammites, with a localised area of Glen Achall psammite and semipelite in the southwest.

3.2.2 The main panel of **Figure 8.4.3** shows the superficial geology of the Site, also derived from BGS digital data. This indicates alternating bands of peat and Devensian (glacial) till running west to east across the Site, with hummocky glacial deposits in the lower slopes west of Meoir Langwell.

3.2.3 There are no geological designations within the Site.

3.3 Hydrology

3.3.1 The Site is drained by numerous watercourses, which can be broadly grouped into two areas, those draining into the River Einig in the west and then into Strath Oykel, and those draining directly into the River Oykel within Strath Oykel, all of which are confluent with the Allt a Bhraigh that exits the basin into the floodplain of the Strath Oykel.

3.3.2 In the west, minor tributaries are generally short steepland streams arranged in parallel and falling directly to the River Einig. The Allt na Mna Baine is the only named watercourse crossed by the western access route option before a bridge over the River Einig.

3.3.3 Within the Site, watercourse crossings have been limited by routing the main wind farm track around the southern boundary or by using existing tracks put in place to support forestry. **Technical Appendix 8.7** (EIA Report, Volume 4) provides full details of all watercourses and crossings and associated environmental sensitivities. Key watercourses are shown on **Figure 8.4.4**.

3.3.4 The natural hydrology of the peatland within the Site has been heavily modified by forestry, both at the ground surface (by ploughing of ridges and furrows), by drains (cut to improve moisture conditions for trees) and drains cut to improve land in the open fells along the western access track option.

3.3.5 There are relatively few water bodies within the Site, Loch Phail in the west and Loch Mhic-Mharsail (situated along the eastern access track option).

3.4 Land Use

3.4.1 The primary land use within the Site is forestry, with the vast majority of turbines and associated access tracks comprising forest coupes.

3.4.2 There is a small area of peat cuttings on steeper slopes away from infrastructure in the north of the Site.

3.5 Peat Depth and Character

3.5.1 Peat depth probing was undertaken in several phases in accordance with Scottish Government (2017) guidance:

- A Phase 1 survey was undertaken on a 100 m grid in July 2024, comprising 1,059 probes and 12 cores.
- A first Phase 2 survey was undertaken on a 10 m grid within infrastructure and along track alignments at 50 m intervals with 10 m offsets from February to March 2025. A further 4,106 locations were probed.
- A second set of Phase 2 probing was undertaken in April 2025 accommodating adjusted infrastructure locations and borrow pits and adding a further 1,164 probes.
- A third set of Phase 2 probing was undertaken in May 2025 to characterise the design freeze and western access track option, adding another 738 locations.

3.5.2 Across all surveys, a total of 7,067 probes were collected and 12 cores. The peat survey report (**Technical Appendix 8.2** (EIA Report Volume 4)) documents the findings of these site investigations.

3.5.3 Interpolation of peat depths was undertaken in the ArcMap GIS environment using a natural neighbour approach. This approach was selected because it preserves recorded depths at each probe location, unlike some other approaches (e.g. kriging), is computationally simple, and minimises 'bullseye' effects. The approach was selected after comparison of outputs with three other methods (inverse distance weighted, kriging and TIN).

3.5.4 The peat depth model is shown on **Figure 8.4.5** with probing locations superimposed. Peat depth distribution over the Site can be summarised as follows:

- Peat is generally widespread above the 300 m contour but frequently present in patches below this elevation.
- The deepest peat is present in the higher parts of the Site, generally up to 3.0 m in depth. Peat is shallower or absent over much of the northern half of the Site.
- The western access track option is generally lacking peat other than in small patches.

- The probing data indicates c. 49 % of probes recorded <0.5 m (organic soil), c. 26.5 % 0.5-1.0 m (shallower peat), c. 11.2 % 1.0-1.5 m (deeper peat) and c. 13 % >1.5 m.

3.5.5 Comparison of the peat depth model with the layout indicates that efforts have been made during layout design to site infrastructure out of the deepest peat areas and to route access tracks onto shallower peat.

3.6 Peatland Geomorphology

3.6.1 Satellite imagery available as an ArcGIS Basemap layer was used to interpret and map features within the Site. Additional imagery from different epochs available on both Google EarthTM and bing.com/maps was also referred to in order to validate the satellite imagery interpretation. The resulting geomorphological map (see **Figure 8.4.4**) was subsequently verified during site walkovers undertaken by the peat survey team. **Plates 3.2 and 3.3** show typical features identified during the walkovers.

3.6.2 **Figure 8.4.4** shows the key features of the Site. The presence, characteristics and distribution of these features are helpful in understanding the hydrological function of a peatland, the balance of erosion and peat accumulation (or condition), and the sensitivity of a peatland to potential land-use changes.

Notes: a) diffuse surface drainage adjacent to upper tree line at higher elevation, b) bog pool near a), c) watercourse within ride in centre of Site, d) headwater tributary of Allt Mor near Cnoc nan Con

Plate 3.2: Typical Features On-site

3.6.3 The Site is dominated by afforested peatland within which the peat surface has been ploughed into ridges and furrows to enable tree planting and encourage tree growth through dewatering the shallowest horizons. The majority of the proposed turbines are located entirely, or at least partially in afforested areas (the exceptions being turbines T2 and T7). This has helped keep impacts on peat to areas that have already been degraded through forestry. Rides between forest coupes still retain vegetation that might have been typical of the pre-forestry conditions (e.g. **Plate 3.2c**), but are present only intermittently, typically around watercourses (e.g. **Plate 3.2d**).

3.6.4 In the upper slopes, outside the forest, linear and dendritic gully networks drain the upper slopes and converge to supply water to the numerous parallel watercourses that drain to the north (e.g. **Plates 3.3**

a and b). These watercourses become incised further north within the Site (e.g. **Plate 3.3c**). Surrounding the watercourses and gullies, peat is planar and intact, rather than showing signs of erosion.

3.6.5 In the centre of the Site slopes are open (**Plate 3.3c**) and there is occasional evidence of patterned ground / anastomosing drainage. The watercourses show strong evidence of bedrock control, incising around protruding bedrock exposures.

Notes: a) flush above treeline in southeast of Site, b) well vegetated gully, c) view downvalley of Meoir Leathan from main forestry track, d) typical ground conditions in open fell in centre of site

Plate 3.3: Typical Features On-site

3.6.6 In the lower slopes, as peat thins to soil, rock outcrops are close to surface and terracing is visible on some of the steeper slopes, though not indicative of slope instability. The site walkovers indicated no evidence of incipient instability (cracks, ridges, quaking ground) or previous peat landslides.

4. Assessment of Peat Landslide Likelihood

4.1 Introduction

4.1.1 This section provides details on the landslide susceptibility and limit equilibrium approaches to assess peat landslide likelihood. The assessment of likelihood is a key step in the calculation of risk, where risk is expressed as follows:

Risk = Probability of a Peat Landslide x Adverse Consequences

4.1.2 The probability of a peat landslide is expressed in this report as peat landslide likelihood and is considered below.

4.1.3 Due to the combination of moderate slopes and thinner peat at this Site, the most likely mode of failure is peat slides. This is in keeping with the most likely mode of failure for the peat depths and slope angles present at the Site (see **Plate 2.2** and **Figures 8.4.1** and **8.4.5**).

4.2 Limit Equilibrium Approach

Overview

4.2.1 Stability analysis has been undertaken using the infinite slope model to determine the FoS for a series of 25 m x 25 m grid cells within the Site. This is the most frequently cited approach to quantitatively assessing the stability of peat slopes (e.g. Scottish Government, 2017; Boylan et al, 2008; Evans and Warburton, 2007; Dykes and Warburton, 2007; Creighton, 2006; Warburton et al, 2003; Carling, 1986). The approach assumes that failure occurs by shallow translational landsliding, which is the mechanism usually interpreted for peat slides. Due to the relative length of the slope and depth to the failure surface, end effects are considered negligible and the safety of the slope against sliding may be determined from analysis of a 'slice' of the material within the slope.

4.2.2 The stability of a peat slope is assessed by calculating a FoS, F, which is the ratio of the sum of resisting forces (shear strength) and the sum of driving forces (shear stress) (Scottish Government, 2017):

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

4.2.3 In this formula c' is the effective cohesion (kPa), γ is the bulk unit weight of saturated peat (kN/m^3), γ_w is the unit weight of water (kN/m^3), z is the vertical peat depth (m), h is the height of the water table as a proportion of the peat depth, β is the angle of the substrate interface (°) and ϕ' is the angle of internal friction of the peat (°). This form of the infinite slope equation uses effective stress parameters, and assumes that there are no excess pore pressures, i.e. that the soil is in its natural, unloaded condition. The use of cut and fill foundations and tracks across most of the construction footprint suggests this is an appropriate approach. The choice of water table height reflects the full saturation of the soils that would be expected under the most likely trigger conditions, i.e. heavy rain.

4.2.4 Where the driving forces exceed the shear strength (i.e. where the bottom half of the equation is larger than the top), F is < 1, indicating instability. A factor of safety between 1 and 1.4 is normally taken in engineering to indicate marginal stability (providing an allowance for variability in the strength of the soil, depth to failure, etc). Slopes with a factor of safety greater than 1.4 are generally considered to be stable.

4.2.5 There are numerous uncertainties involved in applying geotechnical approaches to peat, not least because of its high water content, compressibility and organic composition (Hobbs, 1986; Boylan and Long, 2014). Peat comprises organic matter in various states of decomposition with both pore water and water within plant constituents, and the frictional particle-to-particle contacts that are modelled in standard geotechnical approaches are different in peats. There is also a tensile strength component to peat which is assumed to be dominant in the acrotelm, declining with increasing decomposition and depth. As a result, analysis utilising geotechnical approaches is often primarily of value in showing relative stability across a site given credible and representative input parameters rather than in providing an absolute estimate of stability. Representative data inputs have been derived from published literature for drained analyses considering natural site conditions.

4.3 Data Inputs

4.3.1 Stability analysis was undertaken in ArcMap GIS software. A 25 m x 25 m grid was superimposed on the Site and key input parameters derived for each grid cell. In total, c. 14,600 grid cells were analysed. A 25 m x 25 m cell size was chosen because it is sufficiently small to define a credible landslide size and avoid 'smoothing' of important topographic irregularities.

4.3.2 Two forms of analysis have been undertaken:

4.3.3 **Baseline stability:** input parameters correspond to undisturbed peat, prior to construction, and under water table conditions typically associated with instability (i.e. full saturation). Effective stress parameters are used in a drained analysis.

4.3.4 **Modified (loaded) stability:** input parameters correspond to disturbed peat, subsequent to construction, with peat loaded by floating track and typical vehicle loads. Total stress parameters are used in this undrained analysis.

4.3.5 Areas where peat has been excavated (e.g. the excavated peat itself and the peat upslope of the excavation) have not been modelled since it is assumed that safe systems of work will include buttressing of / support to excavations.

4.3.6 **Table 1** shows the input parameters and assumptions for the baseline stability analysis. The shear strength parameters c' and ϕ' are usually derived in the laboratory using undisturbed samples of peat collected in the field and therefore site specific values are often not available ahead of detailed site investigation for a development. Therefore, for this assessment, a literature search has been undertaken to identify a range of credible but conservative values for c' and ϕ' quoted in fibrous and humified peats. FoS analysis was undertaken with conservative ϕ' of 20° and values of 2 kPa and 5 kPa for c'. These values fall at the low end of a large range of relatively low values (when compared to other soils).

4.3.7 **Table 1** shows the input parameters and assumptions for the modified stability analysis. The analysis employs a 5 m wide floating track and assumes representative loads for a multi-axle crane with maximum axle load of 12 t moving over the floated surface.

4.3.8 The analysis assumes pre-loading of the peat by floating track during which the track is built in layers and pore pressures are allowed to dissipate. The combined weight of the track and peat are then modelled in an undrained analysis utilising the heaviest vehicle loads likely to use the access the track.

Results

4.3.9 The outputs of the drained analysis (effective stress) are shown for both parameter combinations in **Figure 8.4.6**. The more conservative combination (minimum c' and ϕ', inset panel) suggests that a significant proportion of the Site is either unstable (F < 1) or of marginal stability (F < 1.4) which is not consistent with site observations nor with the stability of peat in general – peat landslides are very rare occurrences given the wide distribution of peat soils in England, Scotland and Wales. The less conservative combination (main panel) gives more credible results, with only isolated areas showing marginal stability (F < 1.4).

Table 1: Geotechnical Parameters for Drained Infinite Slope Analysis

Parameter	Values	Rationale	Source
Effective cohesion (c')	2, 5	Credible conservative cohesion values for humified peat based on literature review	• 5, basal peat (Warburton et al., 2003) • 8.74, fibrous peat (Carling, 1986) • 7 - 12, H8 peat (Huat et al, 2014) • 5.5 - 6.1, type not stated (Long, 2005) • 3, 4, type not stated (Long, 2005) • 4, type not stated (Dykes and Kirk, 2001)
Bulk unit weight (γ)	10.5	Credible mid-range value for humified catotelmic peat	• 10.8, catotelm peat (Mills, 2002) • 10.1, Irish bog peat (Boylan et al 2008)
Effective angle of internal friction (ϕ')	20, 30	Credible conservative friction angles for humified peat based on literature review (only 20° used in analysis)	• 40 - 65, fibrous peat (Huat et al, 2014) • 50 - 60, amorphous peat (Huat et al, 2014) • 36.6 - 43.5, type not stated (Long, 2005) • 31 - 55, Irish bog peat (Hebib, 2001) • 34 - 48, fibrous sedge peat (Farrell & Hebib, 1998) • 32 - 58, type not stated (Long, 2005) • 23, basal peat (Warburton et al, 2003) • 21, fibrous peat (Carling, 1986)
Slope angle from horizontal (β)	Various	Mean slope angle per 25 m x 25 m grid cell	• 5 m digital terrain model of site
Peat depth (z)	Various	Mean peat depth per 25 m x 25 m grid cell	• Interpolated peat depth model of site
Height of water table as a proportion of peat depth (h)	1	Assumes peat mass is fully saturated (normal conditions during intense rainfall events or snowmelt, which are the most likely natural hydrological conditions at failure)	

Table 2: Geotechnical Parameters and Assumptions for Undrained Infinite Slope Analysis

Parameter	Values	Rationale	Source
Undrained shear strength (S_u)	5	Published values show undrained shear strength is typically very similar to effective cohesion (c')	• 4-30, medium and highly humified (Boylan et al, 2008) • 4, more humified (Boylan et al, 2008) • 5.2, peat type not stated (Long et al, 2005) 5, Irish bog peat (Farrell and Hebib, 1998)
Bulk unit weight (γ)	10.5	Reduction in volume under floating road is balanced by increased density, so pre-load parameters are used	• See **Table 1**
Slope angle from horizontal (β)	Various	Credible slope angles for which floating tracks are proposed	• See **Table 1**
Peat depth (z)	Various	Reduction in volume (i.e. depth) under floating road is balanced by increased density, so pre-load parameters are used	• See **Table 1**
Crane axle load (t)	12 t	Maximum haul weight that is not considered an "abnormal load", corresponds to 8 axle 98 t (800 t capacity) crane	

4.4 Landslide Susceptibility Approach

Overview

4.4.1 The landslide susceptibility approach is based on the layering of contributory factors to produce unique 'slope facets' that define areas of similar susceptibility to failure. These slope facets vary in size and are different to the regular grid used for the FoS approach. The number and size of slope facets varies from one part of the Site to another according to the complexity of ground conditions. In total, c. 20,650 facets were considered in the analysis, with an average area of c. 650 m^2 (or an average footprint of c. 25 m x 25 m), consistent with smaller to medium scale peaty soil or peat slides reported in the published literature.

4.4.2 Eight contributory factors are considered in the analysis: slope angle (S), peat depth (P), substrate geology (G), peat geomorphology (M), drainage (D), slope curvature (C), forestry (F), and land use (L). For each factor, a series of numerical scores between 0 and 3 are assigned to factor 'classes', the significance of which is tabulated for each factor. The higher a score, the greater the contribution of that factor to instability for any particular slope facet. Scores of 0 imply neutral / negligible influence on instability.

4.4.3 Factor scores are summed for each slope facet to produce a peat landslide likelihood score (SPL), the maximum being 24 (8 factors, each with a maximum score of 3).

$$S_{PL} = S_S + S_P + S_G + S_M + S_D + S_C + S_F + S_L$$

4.4.4 In practice, a maximum score is unlikely, as the chance of all contributory factors having their highest scores in one location is very small.

Slope Angle (S)

4.4.5 **Table 3** shows the slope ranges, their association with instability and related scores for the slope angle contributory factor. Slope angles were derived from the 5 m digital terrain model shown on **Figure 8.4.2** and scores assigned based on reported slope angles associated with peat landslides rather than a simplistic assumption that 'the steeper a slope, the more likely it is to fail' (e.g. **Plate 2.2**). A differentiation in scores is applied for peat slides and bog bursts reflecting the shallower slopes on which the latter are most frequently observed.

4.4.6 Note that the slope model is a TIN (interpolated from irregularly spaced measures of elevation) and these sorts of slope model tend to simplify slopes into triangular surfaces – this can have the effect of steepening or shallowing slopes relative to their actual gradients.

Table 3: Slope Classes, Association with Instability and Scores

Slope Range (°)	Association with Instability	Peat Slide
≤2.5	Slope angle ranges for peat slides are based on lower and upper limiting angles for observations of occurrence (see Plate 2.2) and increase with increasing slope angle until the upper limiting angle e.g. peat slides are not observed on slopes <2.5°, while bog bursts are not observed on slopes > 7.5°). It is assumed that beyond 7.5° the mode of failure will be peat slides.	0
2.5 - 5.0		1
5.0 – 7.5		3
7.5 - 10.0		3
>10		3

4.4.7 **Figure 8.4.7** shows the distribution of slope angle scores across the site. Due to the moderate slope angles over much of the Site, large areas have the highest slope score.

Peat depth

4.4.8 **Table 4** shows the peat depths, their association with instability and related scores for the peat depth contributory factor. Peat depths were derived from the peat depth model shown on **Figure 8.4.5** and reflect the peat depth ranges most frequently associated with peat landslides (see **Plate 2.2**).

Table 4: Peat Depth Classes, Association with Instability and Scores

Peat Depth (m)	Association with Instability	Peat Slide
>1.5	Bog bursts are the dominant failure mechanism in this depth range where basal peat is more likely to be amorphous	1
0.5 - 1.5	Peat slides are the dominant failure mechanism in this depth range where basal peat is less likely to be amorphous	3
<0.5	Organic soil rather than peat, failures would be peaty-debris slides rather than peat slides or bog bursts and are outside the scope	0

4.4.9 The distribution of peat depth scores is shown on **Figure 8.4.7**. Due to the shallow to moderate peat depths present in the peaty areas, around 50 % of the Site has the highest score for peat. Where peat becomes deeper in the upper slopes, scores lower.

Substrate Geology (G)

4.4.10 **Table 5** shows substrate type, association with instability and related scores for the substrate geology contributory factor. The shear surface or failure zone of reported peat failures typically overlies an impervious clay or mineral (bedrock) base giving rise to impeded drainage. This, in part, is responsible for the presence of peat, but also precludes free drainage of water from the base of the peat mass, particularly under extreme conditions (such as after heavy rainfall, or snowmelt).

4.4.11 Peat failures are frequently cited in association with glacial till deposits in which an iron pan is observed in the upper few centimetres (Dykes and Warburton, 2007). They have also been observed over glacial till without an obvious iron pan, or over impermeable bedrock. They are rarely cited over permeable bedrock, probably due to the reduced likelihood of peat formation.

Table 5: Substrate Geology Classes, Association with Instability and Scores

Substrate Geology	Association with Instability	Peat Slide
Cohesive (clay) or iron pan	Failures are often associated with clay substrates and/or iron pans	3
Granular clay or clay dominated alluvium	Failures are more frequently associated with substrates with some clay component	2
Granular or bedrock	Failures are less frequently associated with bedrock or granular (silt / sand / gravel) substrates	1

4.4.12 Probing undertaken across the site indicated primarily bedrock or granular substrates using the refusal method, with the exception of two locations where clay was identified. Coring confirmed this and no iron pans were observed (see **Appendix 8.2**). Accordingly, the vast majority of the site is treated as if underlain by impermeable bedrock or granular glacial till (**Figure 8.4.7**).

Peat Geomorphology (M)

4.4.13 **Table 6** shows the geomorphological features typical of peatland environments, their association with instability and related scores.

Table 6: Peat Geomorphology Classes, Association with Instability and Scores

Geomorphology	Association with Instability	Peat Slide
Incipient instability (cracks, ridges, bulging)	Failures are likely to occur where pre-failure indicators are present	3
Planar with pipes	Failures generally occur on planar slopes, and are often reported in areas of piping	3
Planar with pools / quaking bog	Bog bursts are more likely in areas of perched water (pools) or subsurface water bodies (quaking bog)	2
Flush / Sphagnum lawn (diffuse drainage)	Peat slides are often reported in association with areas of flushed peat or diffuse drainage	3
Planar (no other features)	Failures generally occur on planar slopes rather than dissected or undulating slopes	2
Peat between rock outcrops	Failures are rarely reported in areas of peat with frequent rock outcrops	1
Slightly eroded / anastomosing drainage / patterned ground	Failures are rarely reported in eroded areas or areas of strong ground patterning from micro-scale erosion	1
Heavily eroded (extensive gullies) / bare peat	Failures are not reported in areas that are heavily eroded or bare	0
Afforested / deforested peatland	Considered within Forestry (F), see below	0

4.4.14 Areas of planar ground in the open areas in the centre and north of the Site have the highest scores. Other than local areas of flushed ground where watercourses become diffuse at the surface.

Artificial Drainage (D)

4.4.15 **Table 7** shows artificial drainage feature classes, their association with instability and related scores. Transverse (or contour aligned) / oblique artificial drainage lines may reduce peat stability by creating lines of weakness in the peat slope and encouraging the formation of peat pipes. A number of peat failures have been identified in published literature which have failed over moorland grips (Warburton et al, 2004). The influence of changes in hydrology becomes more pronounced the more transverse the orientation of the drainage lines relative to the overall slope.

Table 7: Drainage Feature Classes, Association with Instability and Scores

Drainage Feature	Association with Instability	Peat Slide
Drains aligned along contours (<15 °)	Drains aligned to contour create lines of weakness in slopes	3
Drains oblique (15-60°) to contour	Most reports of peat slides and bog bursts in association with drainage occurs where drains are oblique to slope	2
Drains aligned downslope (<30° to slope)	Failures are rarely associated with artificial drains parallel to slope or adjacent to natural drainage lines	1
No / minimal artificial drainage	No influence on stability	0

4.4.16 The effect of drainage lines is captured through the use of a 30 m buffer on each artificial drainage line (producing a 60 m wide zone of influence) present within the peat soils at the Site. Each buffer is assigned a drainage feature class based on comparison of the drainage axis with elevation contours (transverse, oblique or aligned, as shown in **Table 7**). Buffers are shown on **Figure 8.4.7**.

Slope Curvature (C)

4.4.17 **Table 8** shows slope (profile) curvature classes, association with instability and related scores. Convex and concave slopes (i.e. positions in a slope profile where slope gradient changes by a few degrees) have frequently been reported as the initiation points of peat landslides by a number of authors. The geomechanical reason for this is that convexities are often associated with thinning of peat, such that thicker peat upslope applies stresses to thinner 'retaining' peat downslope. Conversely, buckling and tearing of peat may trigger failure at concavities (e.g. Dykes & Warburton, 2007; Boylan and Long, 2011). However, review of reported peat landslide locations against Google Earth elevation data indicates that the majority of peat slides occur on rectilinear (straight) slopes and that the reporting of convexity as a key driver may be misleading. Accordingly, rectilinear slopes are assigned the highest score.

Table 8: Slope curvature Classes, Association with Instability and Scores

Profile Curvature	Association with Instability	Peat Slide
Rectilinear Slope	Peat slides are most frequently reported on rectilinear slopes, while bog bursts are often reported on rectilinear slopes	3
Convex Slope	Peat slides are often reported on or above convex slopes while bog bursts are most frequently associated with convex slopes	2
Concave Slope	Peat failures are occasionally reported in association with concave slopes	1

4.4.18 The OS Terrain 5 digital terrain model was used to identify areas of noticeable slope curvature across the Site. An ArcGIS geoprocessing model was used to calculate slope curvature into concave, convex and rectilinear slopes and 'flat' areas, i.e. those with minimal rate of gradient change on subdued terrain. Curvature scores are shown on **Figure 8.4.7** in accordance with **Table 8**.

Forestry (F)

4.4.19 **Table 9** shows forestry classes, their association with instability and related scores. A report by Lindsay and Bragg (2004) on Derrybrien suggested that row alignments, desiccation cracking and loading (by trees) could all influence peat stability.

Table 9: Forestry Classes, Association with Instability and Scores

Forestry Class	Association with Instability	Peat Slide
Deforested, rows oblique to slope	Deforested peat is less stable than afforested peat, and inter ridge cracks oblique to slope may be lines of weakness	3
Deforested, rows aligned to slope	Deforested peat is less stable than afforested peat, but slope aligned inter ridge cracks have less impact	2
Afforested, rows oblique to slope	Afforested peat is more stable than deforested peat, but inter ridge cracks oblique to slope may be lines of weakness	2
Afforested, rows aligned to slope	Afforested peat is more stable than deforested peat, but potentially less stable than unforested (never planted) peat	1
Windblown	Windblown trees have full disruption to the underlying peat and residual hydrology due to root plate disturbance	0
Not afforested	No influence on stability	0

4.4.20 The majority of Site is afforested, though with most of the forestry coupes with ridge and furrows aligned downslope, thereby attracting a low score (see **Figure 8.4.7**).

Land Use (L)

4.4.21 **Table 10** shows land use classes, association with instability and related scores. A variety of land uses have been associated with peat failures (see **Section 2.3.2**). While it is hypothesised that burning may cause desiccation cracking in peat and facilitate water flows to basal peat (and potential shear surfaces), there is little evidence directly relating burnt ground to peat landslide events.

Table 10: Land Use Classes, Association with Instability and Scores

Land Use	Association with Instability	Peat Slide
Machine cutting	Machine cutting may compartmentalise slopes, but has been reported primarily in association with peat slides	3
Quarrying	Quarrying may remove slope support from upslope materials, and has been observed with spreading failures (bog bursts)	2
Hand cutting (turbary)	Hand cutting may remove slope support from upslope materials, and has been reported with raised bog failures	1
Burning (deep cracking to substrate)	Failures are rarely associated with burning, but deep desiccation cracking will have the most severe effects	2
Burning (shallow cracking)	Failures are rarely associated with burning, shallow desiccation cracking will have very limited effects	1
Grazing	Failures have not been associated with grazing, no influence on stability	0

4.4.22 Aside from forestry, which is considered in the previous factor, there are no major land uses within the Site and therefore the site is assigned a 0 score (other than in a small area adjacent to cuttings (see **Figure 8.4.8**).

Generation of Slope Facets

4.4.23 The eight contributory factor layers shown on **Figure 8.4.8** were combined in ArcMap to produce approximately 20,650 slope facets. Scores for each facet were then summed to produce a peat landslide likelihood score. These likelihood scores were then converted into descriptive 'likelihood classes' from 'Very Low' to 'Very High' with a corresponding numerical range of 1 to 5 (in a similar format to the Scottish Government BPG).

Table 11: Likelihood Classes Derived from the Landslide Susceptibility Approach

Summed Score from Contributory Factors	Typical Site Conditions Associated with Score	Likelihood (Qualitative)	Landslide Likelihood Score
≤ 7	Unmodified peat with no more than low weightings for peat depth, slope angle, underlying geology and peat morphology	Very Low	1
8 - 12	Unmodified or modified peat with no more than moderate or some high scores for peat depth, slope angle, underlying geology and peat morphology	Low	2
13 - 17	Unmodified or modified peat with high scores for peat depth and slope angle and / or high scores for at least three other contributory factors	Moderate	3
18 - 21	Modified peat with high scores for peat depth and slope angle and several other contributory factors	High	4
> 21	Modified peat with high scores for most contributory factors (unusual except in areas with evidence of incipient instability)	Very High	5

Results

4.4.24 **Figure 8.4.8** shows the outputs of the landslide susceptibility approach for peat slides. The results indicate that the majority of the Site has a 'Low' or Very Low likelihood of peat slide under natural conditions. Small areas of Moderate likelihood are present along the ridge margins in the southeast of the Site and in scattered localities in the middle of the Site.

Combined Landslide Likelihood

4.4.25 **Figure 8.4.9** shows in purple any proposed areas of infrastructure of greater than 25 m in length intersecting with areas of moderate or higher landslide susceptibility (from the contributory factor approach) or Factor of Safety of 1.4 or less (from the limit equilibrium approach, including floating track). A 25 m overlap has been selected as this is considered the minimum size of a potentially environmentally significant landslide, while also being representative of the smaller end of reported peat landslides. There are no areas of floating track associated with Unstable or Marginally Stable cells from the crane-loaded undrained assessment (although the results are shown for context on **Figure 8.4.9**).

4.4.26 In order for there to be a "Medium" or "High" risk (Scottish Government, 2017), likelihoods must be "Moderate" or higher (see **Plate 4.1**) and hence this provides a screening basis for the likelihood results.

4.4.27 In all 13 source zones have been identified. There are two zone clusters where source zones occur in close proximity. For the purpose of risk assessment, they are reported under the single largest zone in each location:

- Zone 2 and 3 are immediately adjacent to one another and assessed as part of the larger zone 2.
- Zones 8, 9 and 10 form three sides of a triangular junction and are assessed as part of the largest zone, zone 9.

4.4.28 Overall, this results in 10 runout pathways from the 13 source zones.

5. Assessment of Consequence and Risk

5.1 Introduction

5.1.1 In order to calculate risks, the potential consequences of a peat landslide must be determined. This requires identification of receptors and an assessment of the consequences for these receptors should a peat landslide occur. This section describes the consequence assessment and then provides risk results based on the product of likelihood and consequence.

5.2 Receptors

5.2.1 Peat uplands are typically host to the following receptors: watercourses and associated water supplies (both private and public), terrestrial habitats, and infrastructure, both those that are related to the wind farm and other infrastructure, e.g. roads and power lines. These are considered for the Proposed Development below.

Watercourses

5.2.2 The Site is drained by numerous watercourses, all of which drain into the River Oykel, either via the River Einig in the west or via the Allt a Bhraigh which runs out of the north of the Site along the red line boundary.

5.2.3 **Chapter 8** (EIA Report Volume 2) indicates that the sensitivity of the Allt a Bhraigh is High, while the tributary streams to it are of Medium sensitivity. The River Einig and River Oykel are considered of Very High sensitivity due to being designated SACs for freshwater pearl mussels and Atlantic Salmon. High sensitivity watercourses are assigned a score of 4, and Medium sensitivity watercourses a score of 3. No source zones have been identified that would lead to direct runout into either the River Einig or River Oykel. Indirect runout is considered in the assessment below.

Habitats

5.2.4 Blanket bog habitats are generally absent over the majority of the Site due to forestry, and therefore a low consequence score of 2 has been assigned for habitats (**Table 12**).

Table 12: Receptors Considered in the Consequence Analysis

Receptor and type	Consequence	Score	Justification for Consequence Score
Designated watercourses (River Einig and River Oykel)	Short term increase in turbidity and acidification, potential fish kill and smothering of river substrate	5	Highest level of watercourse protection
Watercourses (Allt a Bhraigh)	Short term increase in turbidity and acidification, potential fish kill and smothering of river substrate	4	Undesignated watercourse, no sensitive species noted
Other watercourses (including headwater tributaries)	Short term increase in turbidity and acidification, potential fish kill and smothering of river substrate	3	Undesignated watercourse, no sensitive species noted
Terrestrial habitats	Short to medium term loss of vegetation cover, disruption of peat hydrology, carbon release	2	Habitats are generally poor across the Site due to the widespread presence of forestry
Wind farm infrastructure (Project)	Damage to infrastructure, injury to site personnel, possible loss of life	5	Loss of life, though very unlikely, is a severe consequence; financial implications of damage and re-work are less significant

Infrastructure

5.2.5 The Site is relatively isolated, with non-wind farm infrastructure limited to forestry roads.

5.2.6 Infrastructure that would be most affected in the event of a peat landslide would be the Proposed Development infrastructure. These effects would be most likely during construction, at which time personnel would be using the access track network or be present at infrastructure locations for long periods. While commercial losses would be important to the Applicant, loss of life / injury would be of greater concern, and a consequence score of 5 is assigned for any infrastructure locations subject to potential peat landslides (**Table 12**). However, risks to life can be mitigated through safe systems of working. These infrastructure risks are not considered to be 'environmental' risks and are not explicitly considered in the consequence assessment below.

5.3 Consequences

Overview

5.3.1 A consequence assessment has been undertaken by determining the potential for landslides sourced at infrastructure locations with a Moderate natural likelihood of peat instability to impact the receptors identified above. For example, if a turbine is located in a Moderate (likelihood score of 3) area of open slope and is located 50 m from a watercourse (with a consequence score of 5), it is probable that a landslide triggered during construction would reach that watercourse. The calculated risk would be a product of the likelihood and consequence scores (likelihood: 3 x consequence: 5 = risk: 15, see **Plate 4.1**) and be equivalent to a "Medium" risk.

5.3.2 In order to determine the likelihood of impact on watercourses and infrastructure, runout zones (or pathways) have been defined that show the estimated maximum footprint of the landslide. Runout zones are divided in a downslope direction into 50 m, 100 m, 250 m and 500 m zones on the basis of typical runout distances detailed in Mills (2002). The likelihood of runout passing from one runout zone to the next (e.g. from the 50 m zone into the 100 m zone) is based on the proportion of the published peat landslide population that reaches each runout distance shown on **Plate 5.1** (0-50 m: 100%, 50-100 m: 87%, 100-250 m: 56%, 250-500 m: 44%).

5.3.3 The progress of runout from one runout zone to the next depends on physical constraints within the runout pathway, including watercourses, topography (curvature), forestry and the available volume of landslide material based on the initial slide volume.

Local Limits on Runout

Watercourses

5.3.4 Any runout pathways defined that reach watercourses within 500 m of the source zone are regarded as terminating at this point, debris entering the watercourse and risk being calculated as the product of consequence (dependent on the watercourse consequence score) and likelihood (from section 4). If watercourses contain physical barriers (e.g. weirs), are highly sinuous within low floodplains and may encourage stranding of debris, or if streams are too small to convey material, then runout may also be considered to stall where these restrictions come into effect.

5.3.5 Runout zones 1, 2, 4 and 11 terminate in watercourses, 1, 2 and 4 in tributaries of Allt Mor and 11 in a headwater tributary of Allt a Phris Mhoir.

Slope Curvature

5.3.6 **Plate 5.1** shows runout distances based on published literature. Typically, runout distances would be expected to be less where slope angles decline with distance from the source zone (i.e. on concave slopes) whereas the full runout lengths shown on **Plate 5.1** may be achievable on steepening (convex) slopes or rectilinear slopes. Slopes at the Site are relatively continuous, and therefore this constraint does not apply.

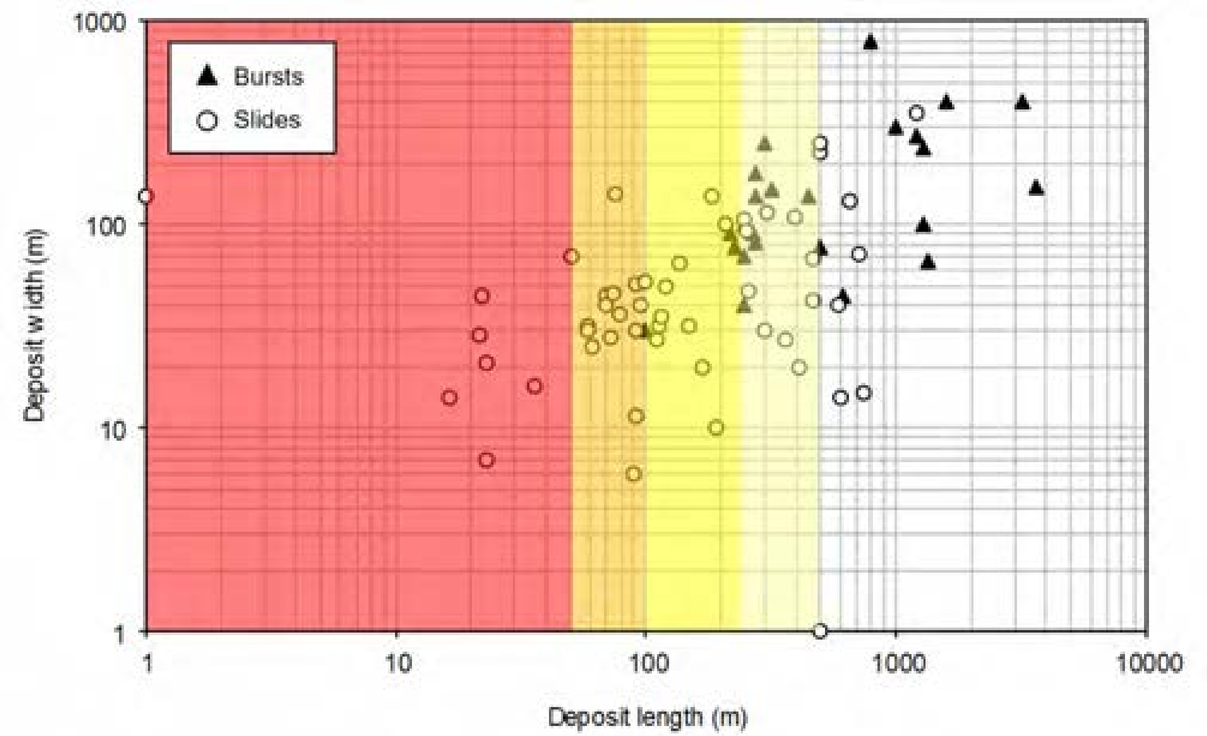

Plate 5.1 Runout Distances for Published Peat Landslides (after Mills, 2002) (colours on the plot correspond to runout zones on Figure 8.4.9)

Forestry

5.3.7 Where keyhole felling is adopted within large-scale commercial forestry, the treeline and forest stands behind it are very likely to limit debris passage through the physical presence of tree stems and ridge and furrow topography. The Felling Plan for the Proposed Development (see **Technical Appendix 2.3**, EIA Report, Volume 4) indicates keyholing for all turbines with very limited cut back along existing and proposed tracks to facilitate blade transport. Within afforested areas, nearly all runout zones will therefore be constrained by retained forestry at the limits of felling or by rough ground associated with brash debris (likely to be present during the construction period, prior to any restoration works that might be specified). This constraint affects all runout zones at some point in their runout pathways.

Peat Thickness in Source Zone

5.3.8 Landslide runout may be "supply-limited" by the availability of peat material generated in the failure or source zone. Typically, mobilised material thins with increasing distance from the source zone as rafts of landslide material break down into blocks, and blocks become abraded and roll, breaking down further into a blocky slurry (**Plate 5.2**).

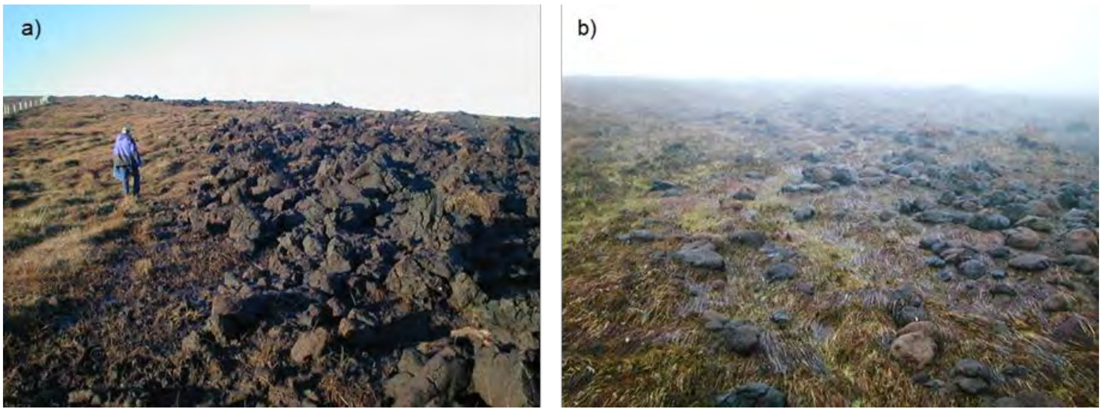

Plate 5.2 Examples of Landslide Runout (Dooncarton, Co. Mayo)

Notes: a) blocky debris mid-slope, b) abraded and rolled blocks in lower slope

5.3.9 Following identification of runout zones, additional analysis has been undertaken to approximate the effect. The analysis assumes a source volume equivalent to the source footprint (if not a track). If the source zone is a track, then the polygon shown as the Source Zone on **Figure 8.4.9** calculated by the length of track squared (up to a length of 50 m, the probable maximum width of landslide). Subsequently, the source footprint is multiplied by the average peat depth in the source zone (from the peat depth model) to calculate a volume, and this volume is then distributed over the full runout pathway (i.e. mobilised volume / runout area) to generate an average thickness of deposit.

5.3.10 As the runout length and area increases, the volume thins, in keeping with observed peat landslide deposits. Where deposits fall below 0.2 m in thickness, it is assumed that runout will stall due to the roughness of surface vegetation relative to the thickness of landslide material. If the thickness is calculated to be 0.2 m or less in the zone adjoining a watercourse, then it is judged that the runout will stall prior to reaching it or be negligible in volume on entry and there will be no significant impact on that watercourse (even if a landslide occurs).

5.3.11 **Plate 5.3** shows a schematic of the full runout approach to assessing consequences.

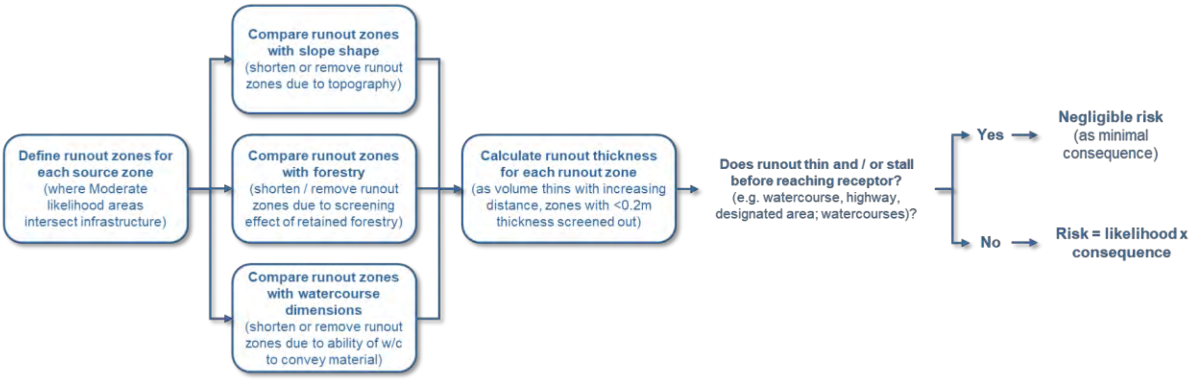

Plate 5.3 Runout Approach to Assessing Consequences

5.3.12 Due to relatively small footprints or thin source depths, runout zones 2, 6, 7, 11, 12, and 13 become constrained by exhausting their supply of peaty debris in their lower runout zones.

5.4 Calculated Risk

5.4.1 **Table 13** summarises the baseline risks (pre-application of depth and forestry constraints, i.e. if the landslides were not supply limited and occurred over open slopes), the key constraints within each zone, and the post-constraint revised risks.

Table 13: Baseline and Revised Risks for Identified Source and Runout Zones

Source Zone	Source Type	Receptor	Baseline Risk Range	Runout Constraint	Revised Risk Range
1	Track near west compound	Headwater tributary of Allt Mor	Low-Negligible	Forestry	Low-Negligible
2	West construction compound	Headwater tributary of Allt Mor	Low-Negligible	Depth / Forestry	Negligible
4	Track by west substation	Headwater tributary of Allt Mor	Low-Negligible	Depth / Forestry	Negligible
5	Track on approach to T7	Forest	Low-Negligible	Forestry	Negligible
6	Track on approach to T7	Forest	Low-Negligible	Depth / Forestry	Negligible
7	Track on approach to T7	Forest	Low-Negligible	Depth / Forestry	Negligible
9	Junction at T8	Forest	Low-Negligible	Forestry	Low-Negligible
11	Track near T8	Headwater tributary of Allt a Phris Mhoir	Medium-Low	Depth / Forestry	Low-Negligible
12	Track near T10	Forest	Low-Negligible	Depth / Forestry	Negligible
13	East construction compound	Forest	Low-Negligible	Depth / Forestry	Negligible

5.4.2 One runout zone is identified with a baseline Medium risk, zone 11_100. This is the first runout zone originating from source zone 11 that encounters a watercourse. The runout pathway overlaps forestry in the upper reaches of the catchment. The risk is generated from a high consequence score of 4 (since the headwater tributary is confluent with Allt a Bhraigh via Allt a Phris Mhoir) and a moderate likelihood score. However, the majority of the watercourse will be shielded by forestry while the track is under construction and the runout is supply limited (depth constrained) after 100 m due to a smaller source volume. Based on this, the revised risk is calculated to be Low. Risks reduce to Negligible further down the runout pathway.

5.4.3 **Figure 8.4.10** shows calculated risks taking into account forestry and depth constraints on runout. Based on the calculated risks shown, site-wide good practice measures should be sufficient to manage and mitigate any remaining construction induced instability risks.

6. Risk mitigation

6.1 Overview

6.1.1 A number of mitigation opportunities exist to further reduce the risk levels identified at the Site. These range from infrastructure specific measures (which may act to reduce peat landslide likelihood, and, in turn, risk) to general good practice that should be applied across the Site to engender awareness of peat instability and enable early identification of potential displacement and opportunities for mitigation.

6.1.2 Risks may be mitigated by:

- Post-consent site specific review of the ground conditions contributing to Moderate likelihoods which may result in a reduced likelihood, and in turn, further reduction in risk.
- Precautionary construction measures - including use of monitoring, good practice and a geotechnical risk register relevant to all locations.

6.1.3 Based on the analysis presented in this report, risks are calculated to be "Low" or "Negligible" across the Site, and site-specific mitigation is not required to reduce risks pre-consent.

6.2 Good Practice Prior to Construction

6.2.1 Site safety is critical during construction, and it is strongly recommended that detailed intrusive site investigation and laboratory analysis are undertaken ahead of the construction period in order to characterise the strength of the peat soils in the areas in which excavations are proposed, particularly where these fall in areas of Moderate (or greater, if present) likelihood. These investigations should be sufficient to:

1. Determine the strength of free-standing bare peat excavations.
2. Determine the strength of loaded peat (where excavators and plant are required to operate on floating hardstandings or track, or where operating directly on the bog surface).
3. Identify sub-surface water-filled voids or natural pipes delivering water to the excavation zone, e.g. through the use of ground penetrating radar or careful pre-excavation site observations.

6.2.2 A comprehensive Geotechnical Risk Register should be prepared post-consent, but pre-construction, detailing sequence of working for excavations, measures to minimise peat slippage, design of retaining structures for the duration of open hole works, monitoring requirements in and around the excavation and remedial measures in the event of unanticipated ground movement. The risk register should be considered a live document and updated with site experience as infrastructure is constructed. Ideally, a contractor with experience of working in deep peat should be engaged to undertake the works.

6.3 Good Practice During Construction

6.3.1 The following good practice should be undertaken during construction:

6.3.2 For excavations:

- Use of appropriate supporting structures around peat excavations (e.g. for turbines, crane pads and compounds) to prevent collapse and the development of tension cracks.
- Avoid cutting trenches or aligning excavations across slopes (which may act as incipient back scars for peat failures) unless appropriate mitigation has been put in place.
- Implement methods of working that minimise the cutting of the toes of slope, e.g. working up-to-downslope during excavation works.
- Monitor the ground upslope of excavation works for creep, heave, displacement, tension cracks, subsidence or changes in surface water content.
- Monitor cut faces for changes in water discharge, particularly at the peat-substrate contact.
- Minimise the effects of construction on natural drainage by ensuring that natural drainage pathways are maintained or diverted such alteration of the hydrological regime of the site is minimised or avoided; drainage plans should avoid creating drainage/infiltration areas or settlement ponds towards the tops of slopes (where they may act to both load the slope and elevate pore pressures).

6.3.3 For cut tracks:

- Maintain drainage pathways through tracks to avoid ponding of water upslope.
- Monitor the top line of excavated peat deposits for deformation post-excavation.
- Monitor the effectiveness of cross-track drainage to ensure water remains free-flowing and that no blockages have occurred.

6.3.4 For floating tracks:

- Allow peat to undergo primary consolidation by adopting rates of road construction appropriate to weather conditions.
- Identify 'stop' rules, i.e. weather dependent criteria for cessation of track construction based on local meteorological data.
- Run vehicles at 50% load capacity until the tracks have entered the secondary compression phase.
- Prior to construction, setting out the centreline of the proposed track to identify any ground instability concerns or particularly wet zones.

6.3.5 For storage of peat and for restoration activities:

- Ensure stored peat is not located upslope of working areas or adjacent to drains or watercourses.
- Undertake site specific stability analysis for all areas of peat storage (if on sloping ground) to ensure the likelihood of destabilisation of underlying peat is minimised.
- Where possible, avoid storing peat on slope gradients >3° and preferably store on ground with neutral slopes and natural downslope barriers to peat movement.
- Monitor effects of wetting / re-wetting stored peat on surrounding peat areas, and prevent water build up on the upslope side of peat mounds.
- Undertake regular monitoring of emplaced peat in restoration areas to identify evidence of creep or pressure on retaining structures (dams and berms).
- Maximise the interval between material deliveries over newly constructed tracks that are still observed to be within the primary consolidation phase.

6.3.6 In addition to these control measures, the following good practice should be followed:

- The geotechnical risk register prepared prior to construction should be updated with site experience as infrastructure is constructed.
- Full site walkovers should be undertaken at scheduled intervals to be agreed with the Local Authority to identify any unusual or unexpected changes to ground conditions (which may be associated with construction or which may occur independently of construction).
- All construction activities and operational decisions that involve disturbance to peat deposits should be overseen by an appropriately qualified geotechnical engineer with experience of construction on peat sites.
- Awareness of peat instability and pre-failure indicators should be incorporated in site induction and training to enable all site personnel to recognise ground disturbances and features indicative of incipient instability.
- A weather policy should be agreed and implemented during works, e.g. identifying 'stop' rules (i.e. weather dependent criteria) for cessation of track construction or trafficking.
- Monitoring checklists should be prepared with respect to peat instability addressing all construction activities proposed for site.

6.3.7 It is considered that taken together, these mitigation measures should be sufficient to reduce risks to construction personnel to Negligible by reducing consequences to minor injury or programme delay (i.e. Moderate consequences) with a Very Low likelihood of occurrence.

6.4 Good Practice Post-Construction

6.4.1 Following cessation of construction activities, monitoring of key infrastructure locations should continue by full site walkover to look for signs of unexpected ground disturbance, including:

- Ponding on the upslope side of infrastructure sites and on the upslope side of access tracks.
- Changes in the character of peat drainage within a 50 m buffer strip of tracks and infrastructure (e.g. upwelling within the peat surface upslope of tracks, sudden changes in drainage behaviour downslope of tracks).
- Blockage or underperformance of the installed site drainage system.
- Slippage or creep of stored peat deposits.

- Development of tension cracks, compression features, bulging or quaking bog anywhere in a 50 m corridor surrounding the site of any construction activities or site works.

6.4.2 This monitoring should be undertaken on a quarterly basis in the first year after construction, biannually in the second year after construction and annually thereafter; in the event that unanticipated ground conditions arise during construction, the frequency of these intervals should be reviewed, revised and justified accordingly.

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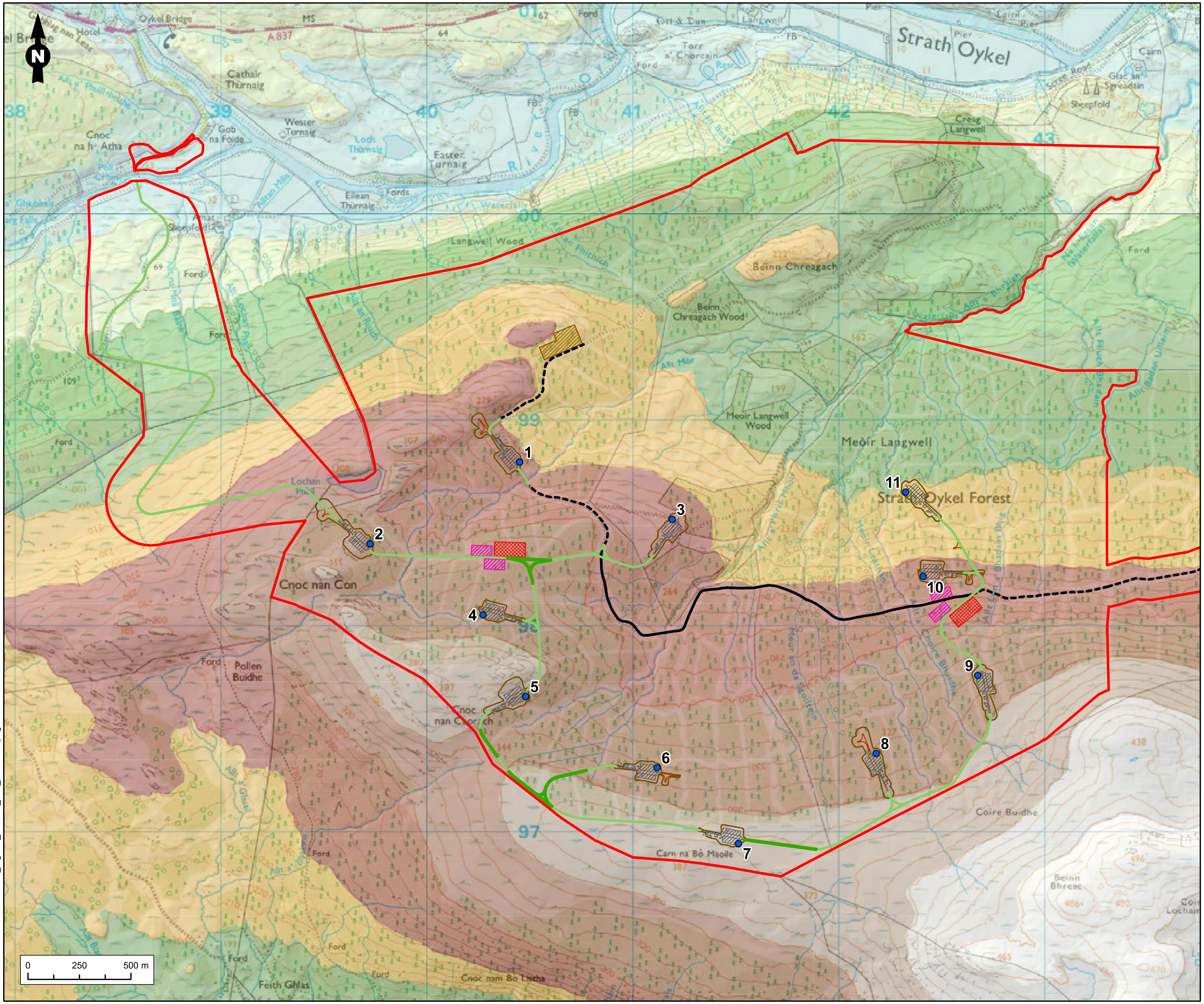
Annex A



Legend

- Study Area
- Proposed Turbine
- Existing Access Track - No Upgrade
- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks

Elevation (m)

- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500

Figure Title
Elevation

Project Name
Coille Beith Wind Farm

Project No./Filery ID
1620016742 / REH2024N00315

Date	Figure No.	Revision
June 2025	8.4.1	1.0

Prepared By	Scale
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Client
Statkraft

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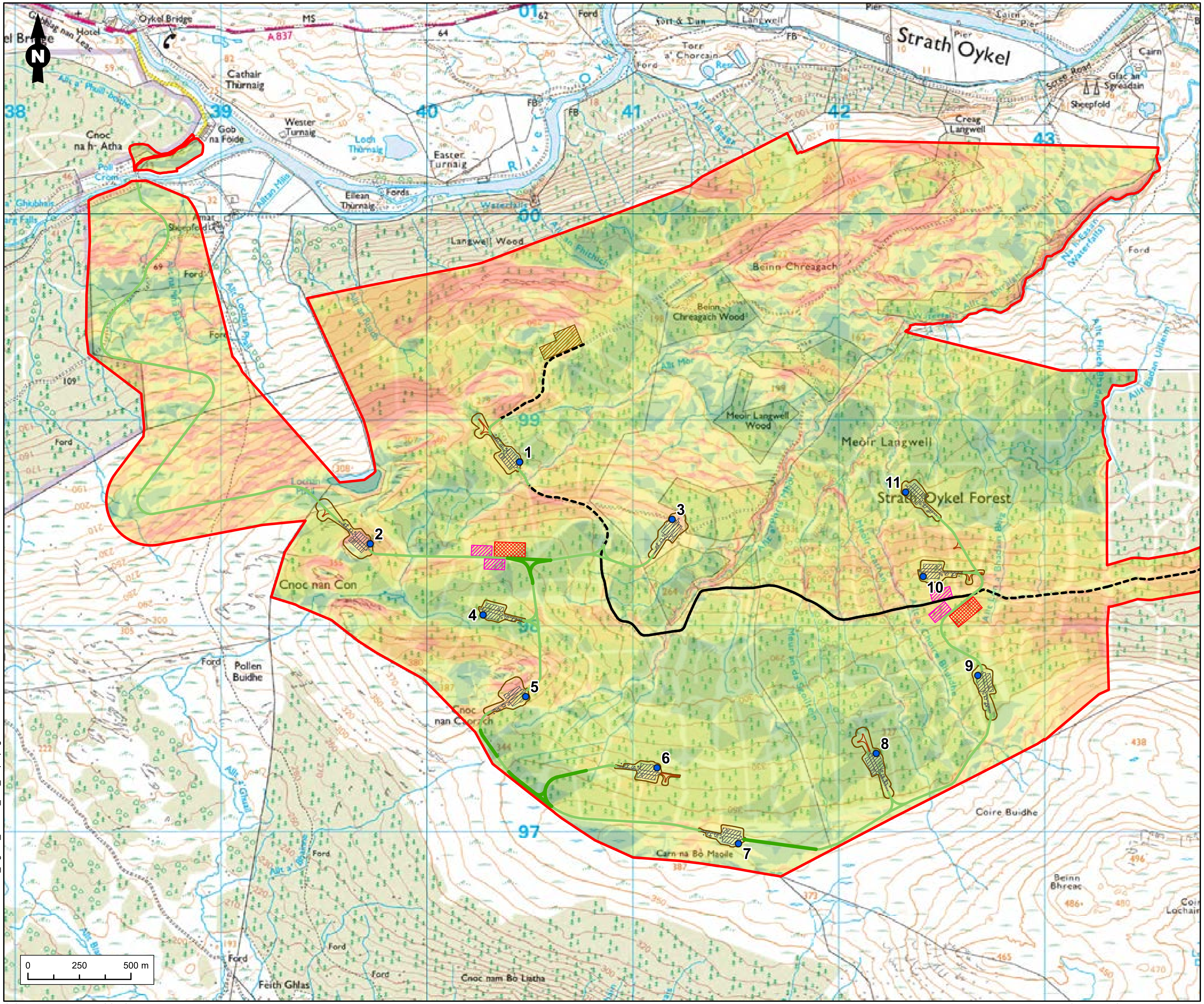

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- Existing Access Track - No Upgrade
- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks

Slope (degrees)

- 0.0 - 2.5
- 2.5 - 5.0
- 5.0- 7.5
- 7.5 - 10.0
- 10.0- 15.0
- > 15.0

Figure Title
Slope

Project Name
Coille Beith Wind Farm

Project No./Filery ID
1620016742 / REH2024N00315

Date	Figure No.	Revision
June 2025	8.4.2	1.0

Prepared By	Scale
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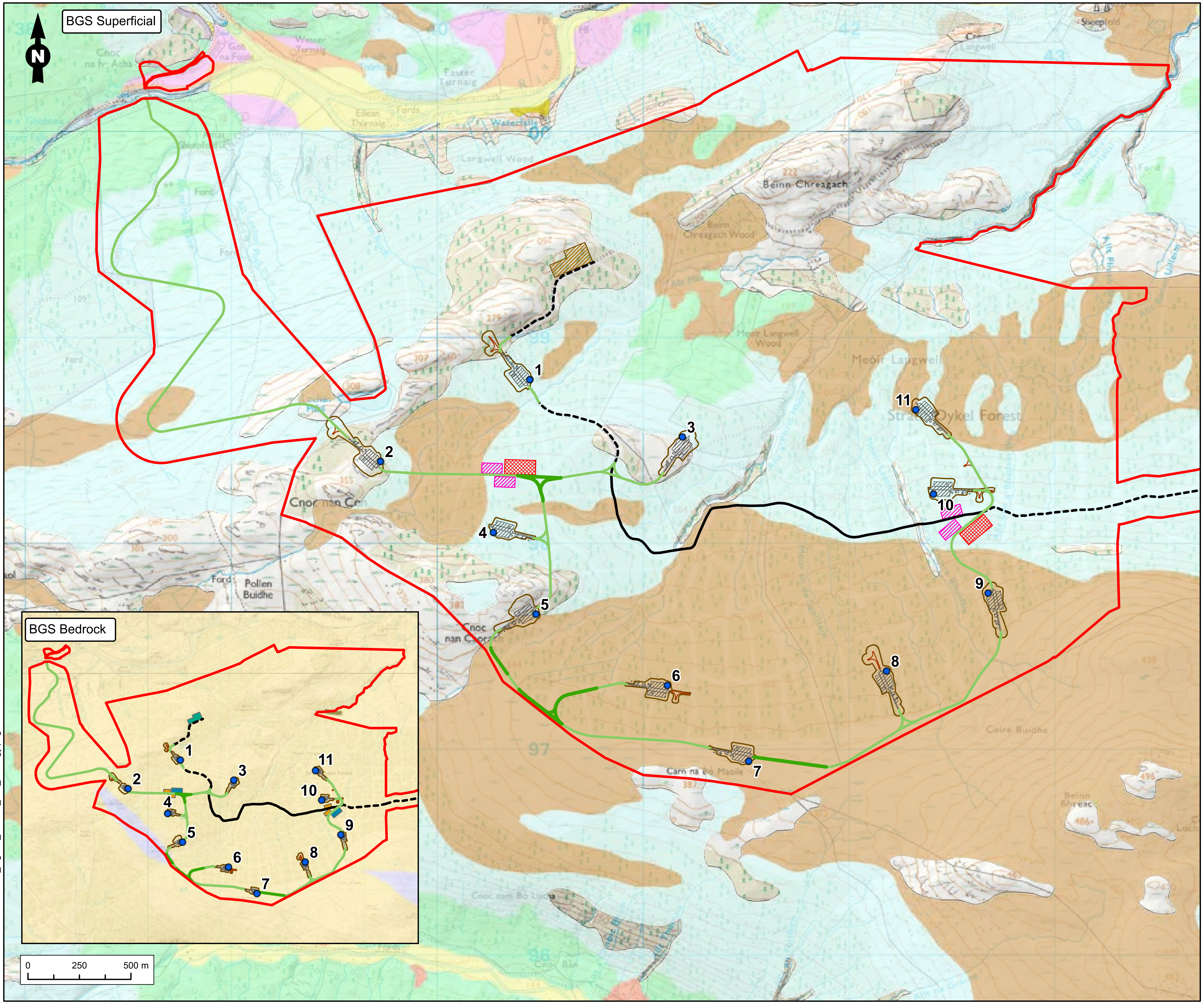

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- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks

BGS Superficial

- Peat
- Till - Devensian
- Glaciofluvial Deposits, Devensian
- Hummocky Glacial Deposits - Devensian

BGS Bedrock

- Altnaharra Psammite Formation Metamorphic
- Glen Achall Psammite and Semipelite - Metamorphic

Figure Title	Geology
Project Name	Coille Beith Wind Farm
Project No./Filery ID	1620016742 / REH2024N00315

Date	Figure No.	Revision
June 2025	8.4.3	1.0

Prepared By	Scale
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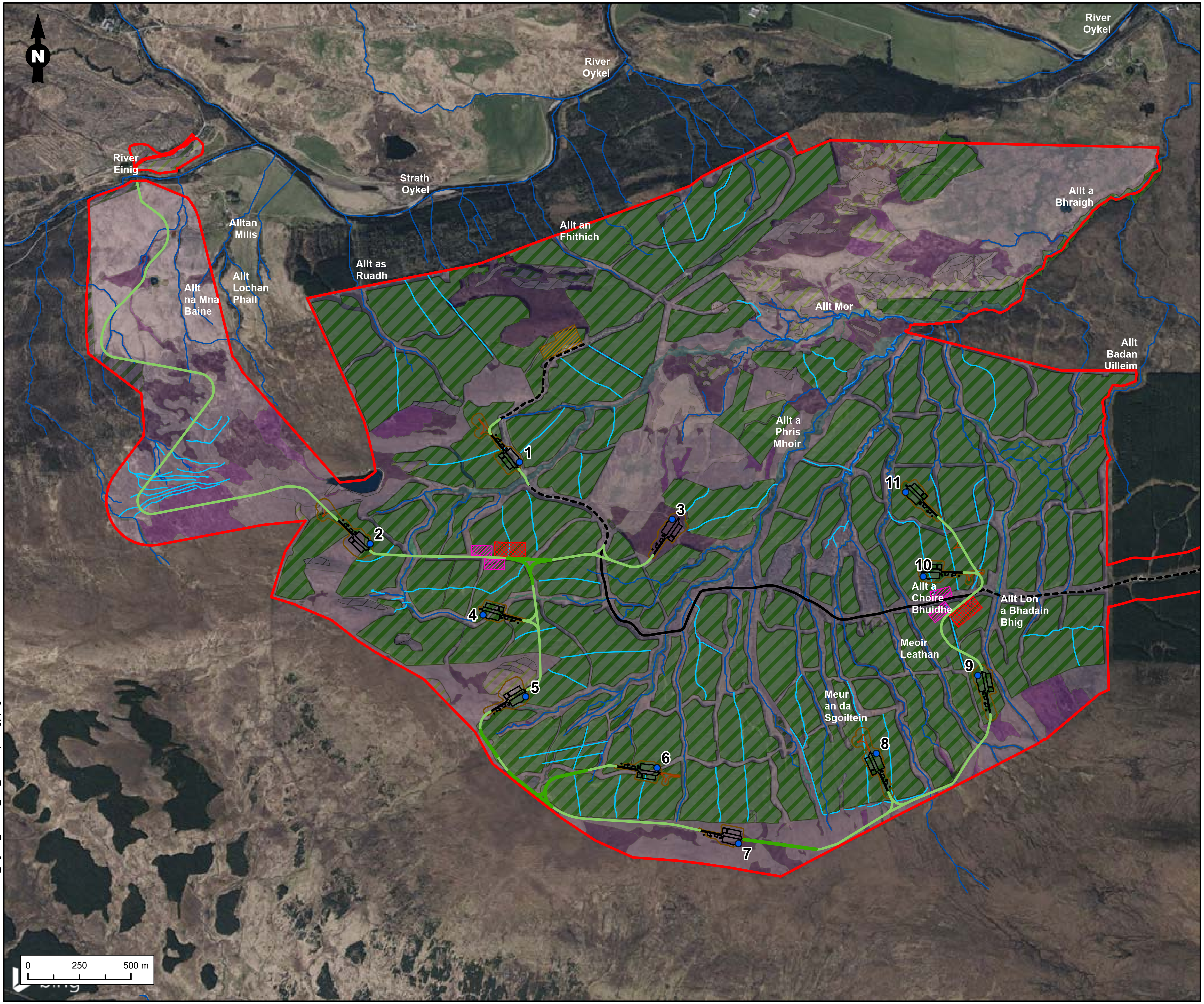

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- Proposed Turbine
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- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Drainage - Artificial
- Drainage - Natural
- Cutting
- Bog pool
- Anastomosing drainage
- Patterned ground
- Dendritic drainage
- Linear drainage
- Gullies
- Made ground
- Planar peat
- Ploughed areas
- Forestry
- Thin peat over bedrock
- Terracing
- Flush / diffuse drainage
- River valley

Figure Title
Geomorphology, hydrology and land use

Project Name
Coille Beith Wind Farm

Project No./Filery ID
1620016742 / REH2024N00315

Date	Figure No.	Revision
June 2025	8.4.4	1.0

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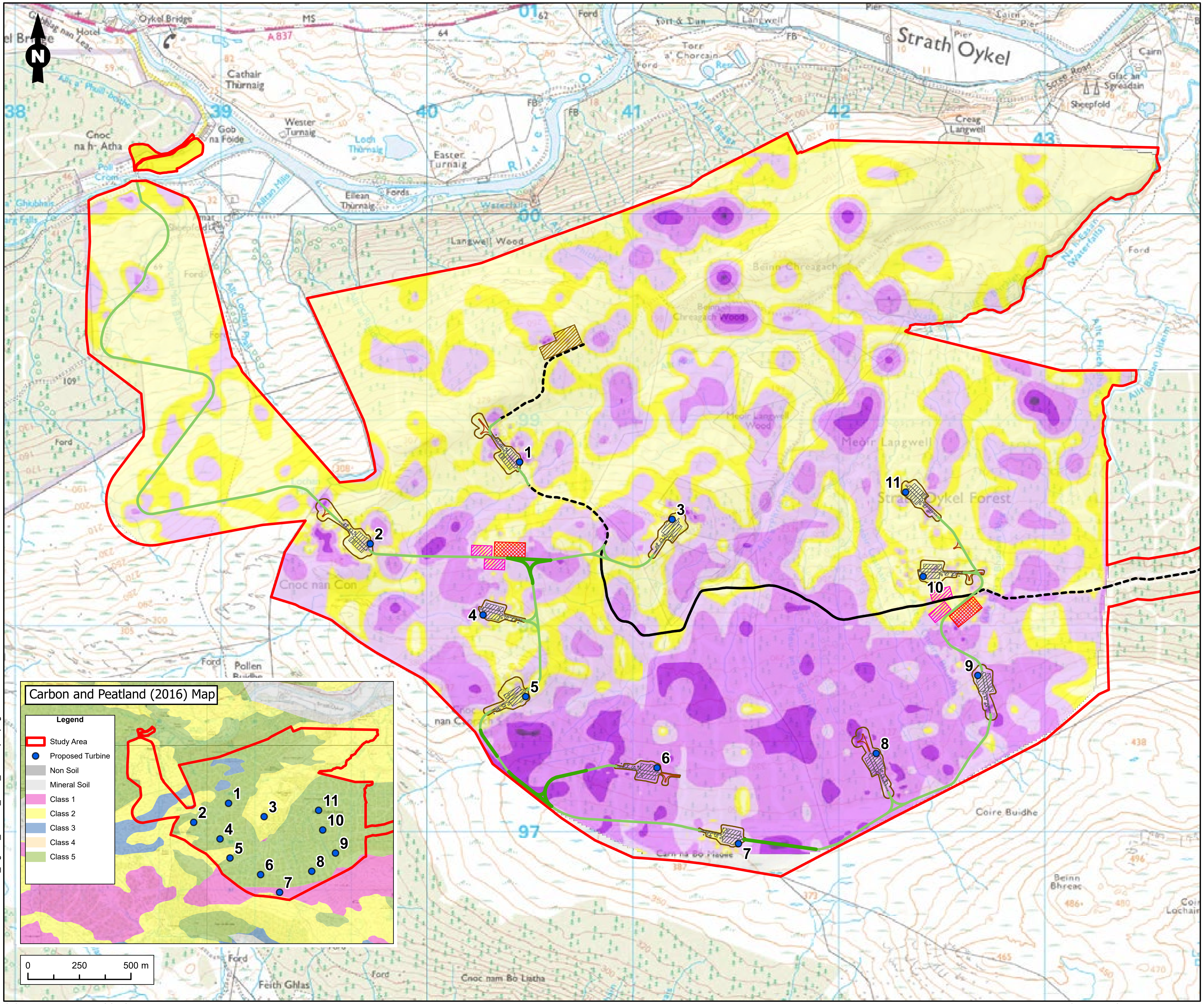

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- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks

Interpolated Peat Depth (m)

- <=0.3
- 0.3-0.5
- 0.5-1
- 1-2
- 2-3
- 3-4

Figure Title	Peat Depth - without probes
Project Name	Coille Beith Wind Farm
Project No./Filery ID	1620016742 / REH2024N00315

Date	Figure No.	Revision
June 2025	8.4.5a	1.0

Prepared By	Scale
OWC-NT	1:17,500 @A3

Client: **Statkraft**

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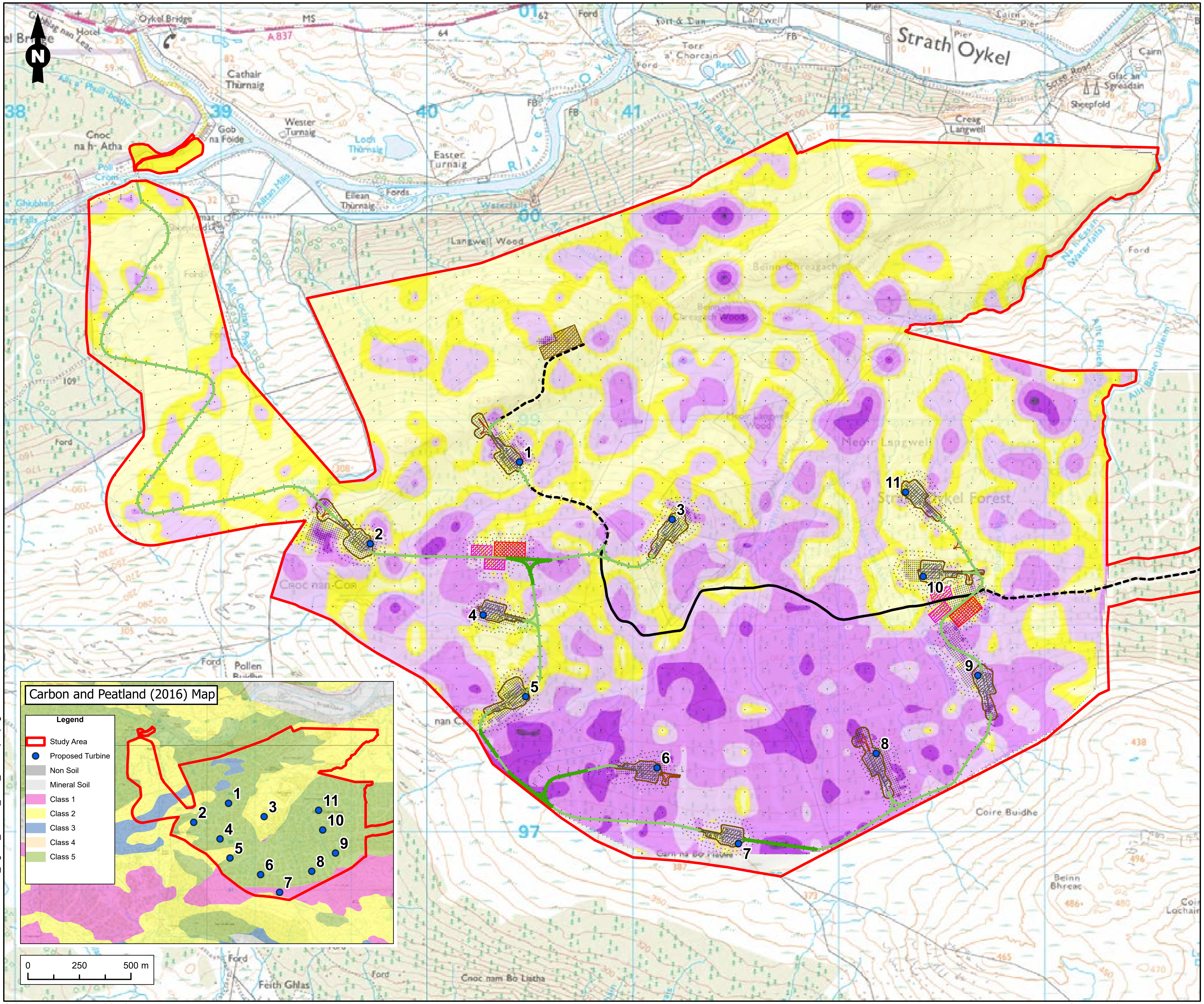

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- Study Area
- Proposed Turbine
- Existing Access Track - No Upgrade
- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Hardstanding
- Peat probe locations

Interpolated Peat Depth (m)

- <=0.3
- 0.3-0.5
- 0.5-1
- 1-2
- 2-3
- 3-4

Figure Title: Peat Depth - with probes		
Project Name: Coille Beith Wind Farm		
Project No./Filery ID: 1620016742 / REH2024N00315		
Date: June 2025	Figure No.: 8.4.5b	Revision: 1.0
Prepared By: OWC-NT	Scale: 1:17,500 @A3	
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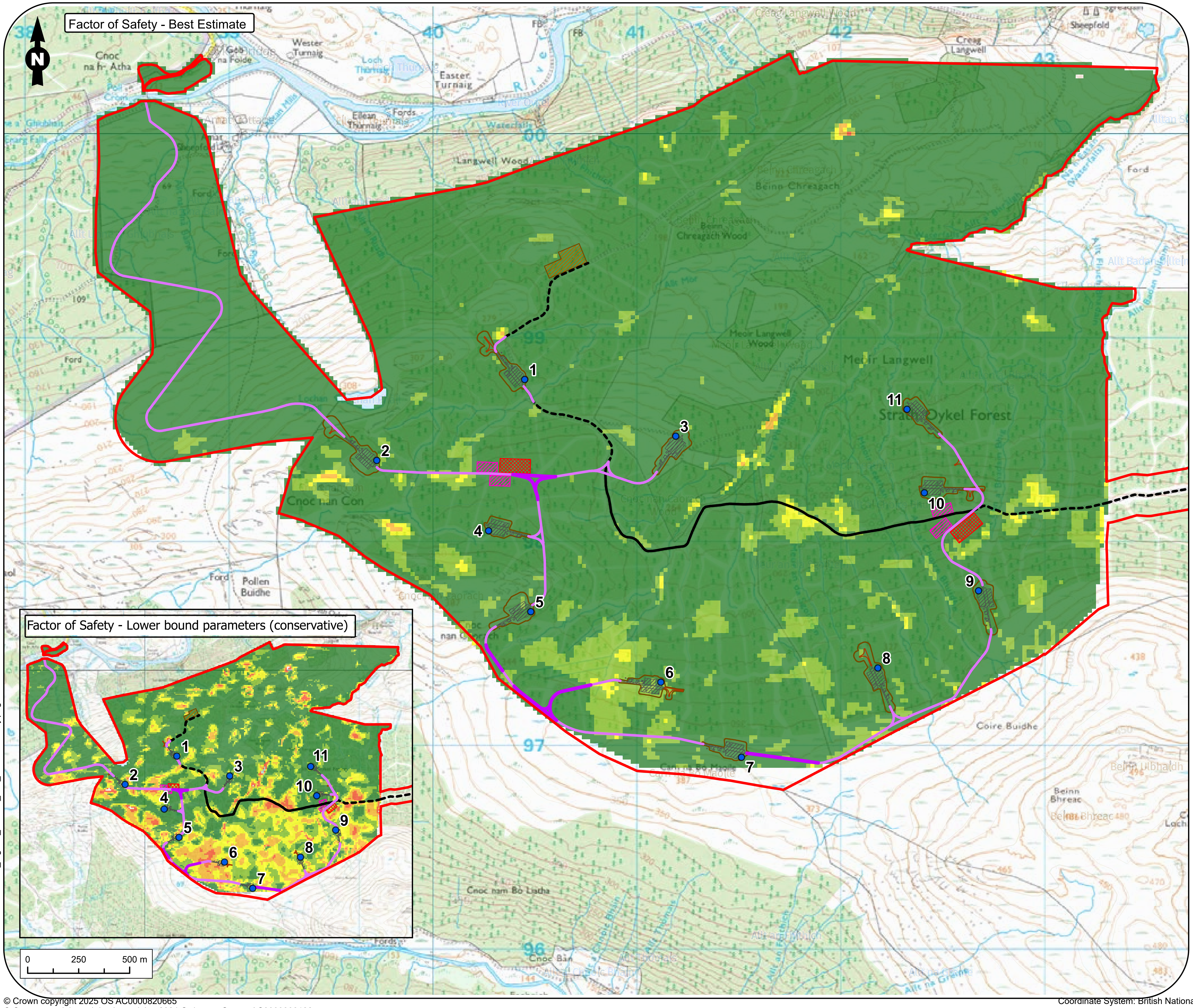

Legend

- Study Area
- Proposed Turbine
- Existing Access Track - No Upgrade
- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks

Factor of Safety

- < 1.00 "Unstable"
- 1.01 - 1.40 "Marginally Stable"
- 1.41 - 2.00 "Stable"
- 2.01 - 3.00 "Stable"
- > 3.01 "Stable"

Figure Title Factor of Safety		
Project Name Coille Beith Wind Farm		
Project No./Filery ID 1620016742 / REH2024N00315		
Date June 2025	Figure No. 8.4.6	Revision 1.0
Prepared By OWC-NT	Scale 1:17,500 @A3	
Client **Statkraft**		

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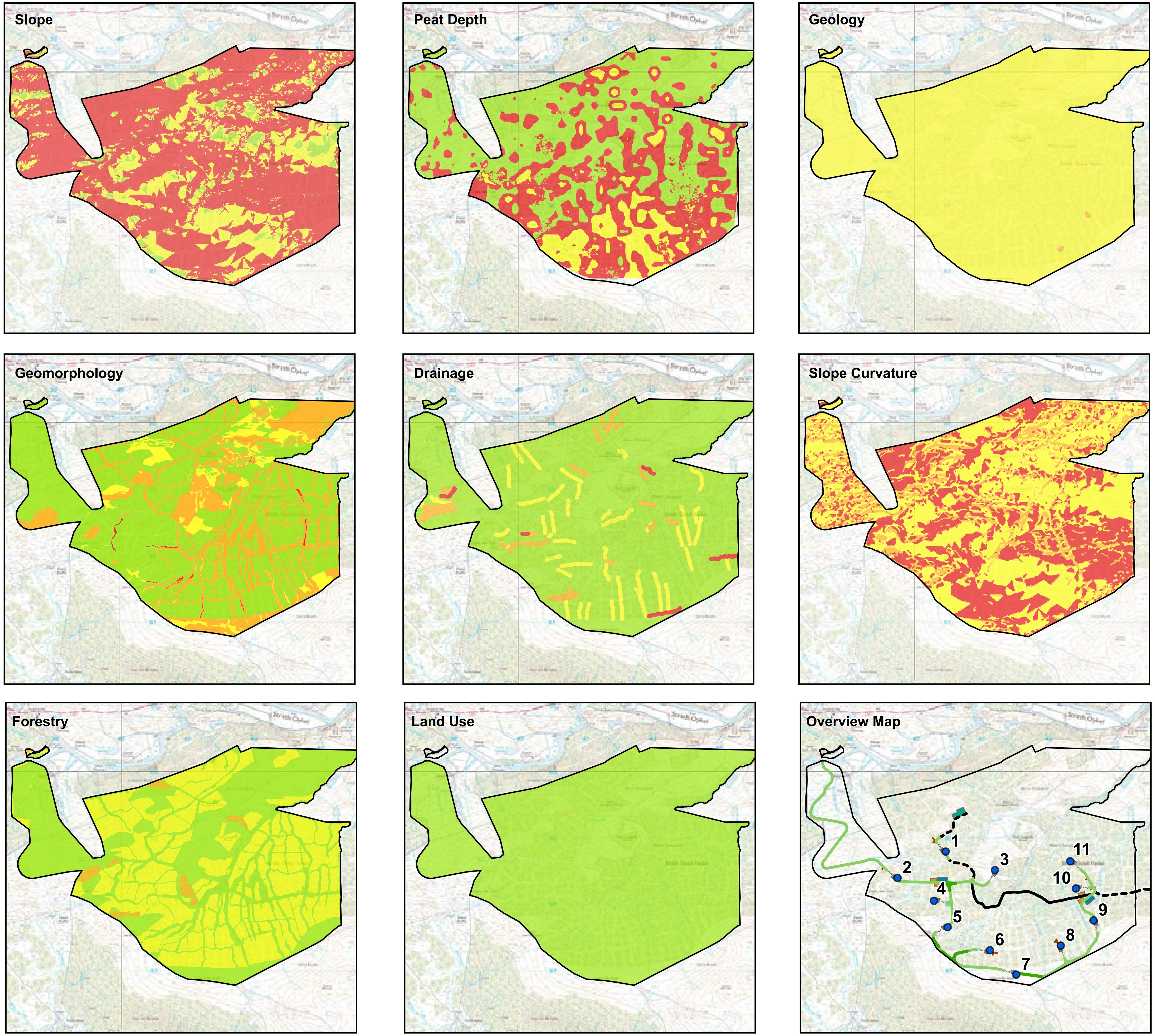

Legend

PLHRA Assessment Area

Contributory Factor Score

- 0
- 1
- 2
- 3

0 500 1,000 2,000 3,000 m

Figure Title	Contributory Factors
Project Name	Coille Beith Wind Farm
Project No./Filery ID	1620016742 / REH2024N00315
Date	June 2025
Figure No.	8.4.7
Revision	1.0
Prepared By	OWC-NT
Scale	1:60,000 @A3
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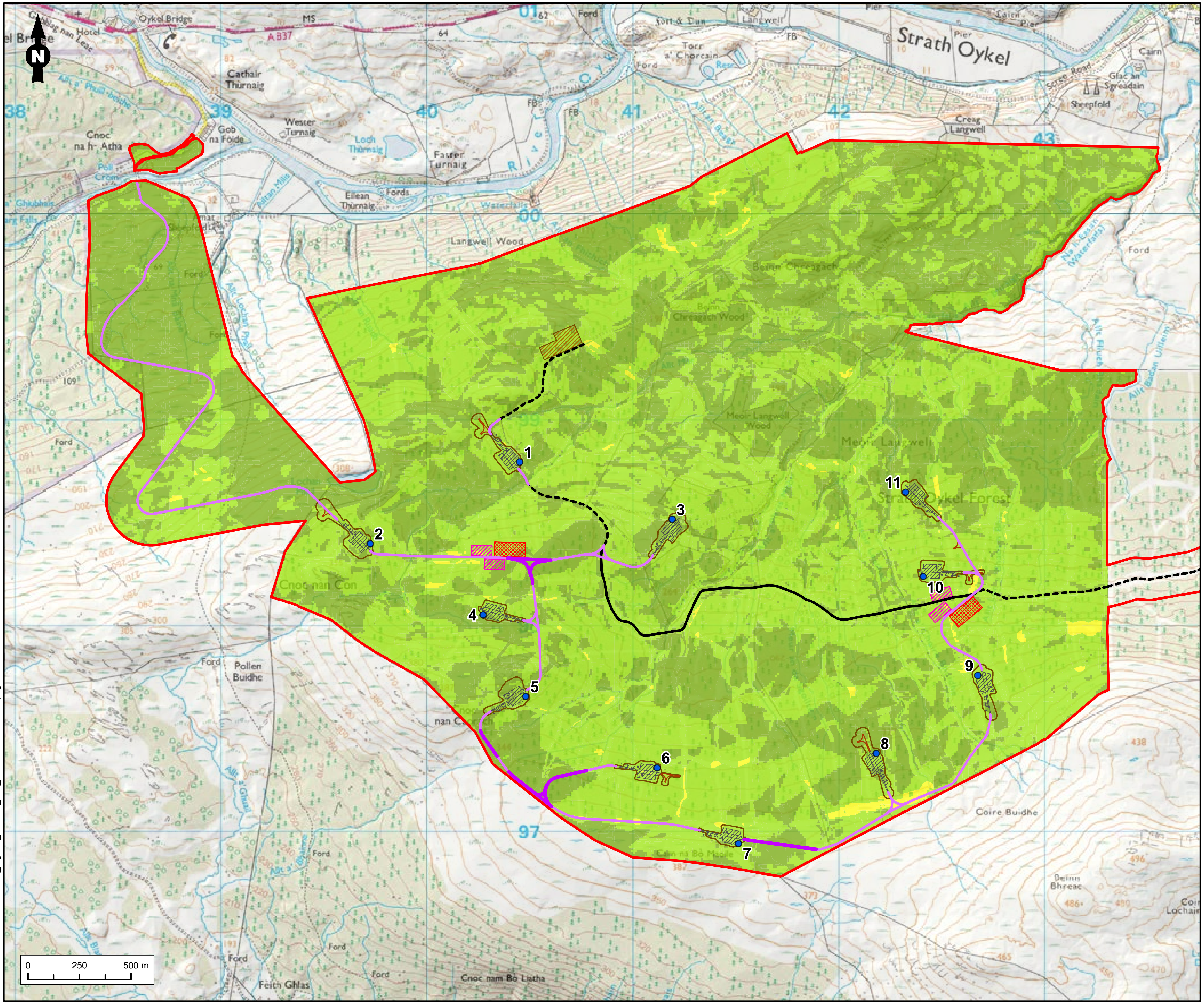


Legend

- Study Area
- Proposed Turbine
- Existing Access Track - No Upgrade
- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks

Landslide Likelihood

- Very low
- Low
- Moderate
- High (none calculated)
- Very high (none calculated)

Figure Title
Landslide Likelihood

Project Name
Coille Beith Wind Farm

Project No./Filery ID
1620016742 / REH2024N00315

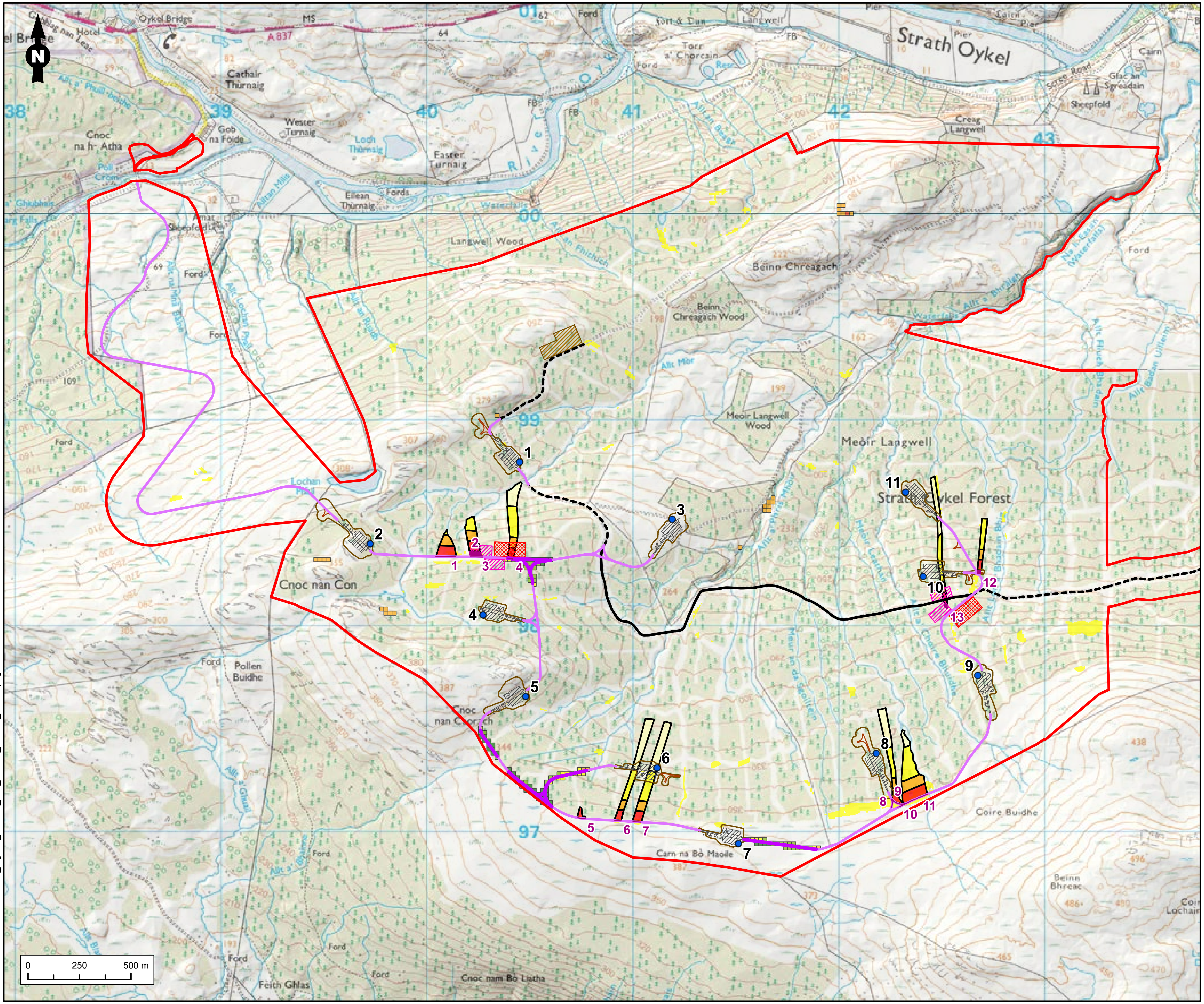
Date	Figure No.	Revision
June 2025	8.4.8	1.0

Prepared By	Scale
OWC-NT	1:17,500 @A3

Client
Statkraft

1620016742-RAM-MA-IA-0000X_FigxA3_PLHRA_L08_LandslideLikelihood.pagx

Coordinate System: British National Grid. Projection: Transverse Mercator. Datum: OSGB 1936.



Legend

- Study Area
- Proposed Turbine
- Existing Access Track - No Upgrade
- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks
- Source zones

Runout Zones (Distance m)

- 50
- 100
- 250
- 500

Landslide Likelihood

- 13 - 15 (Moderate)

Factor of Safety

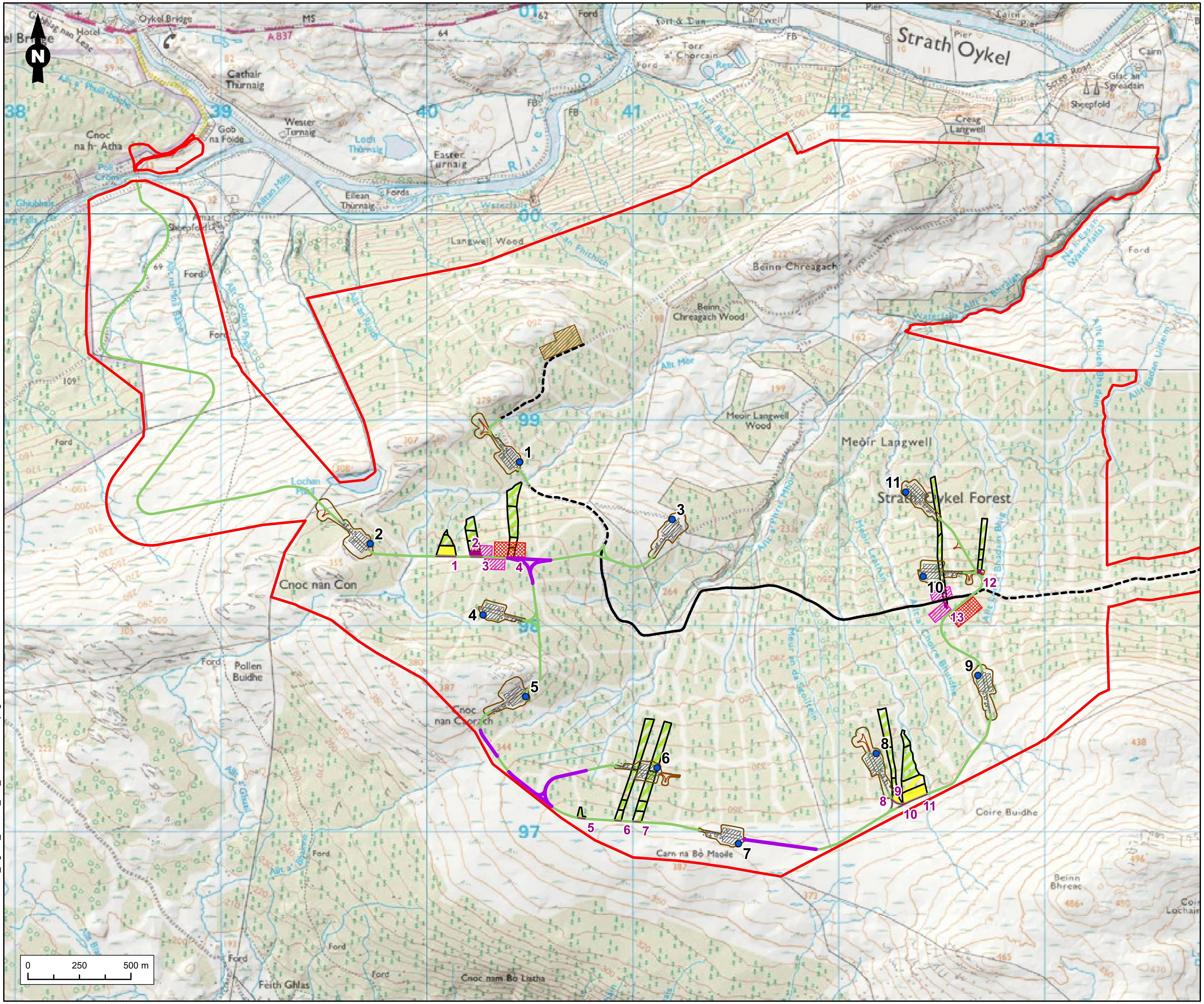
- < 1.00 "Unstable" (None Calculated)
- 1.01 - 1.40 "Marginally Stable" (None Calculated)
- 1.41 - 2.00 "Stable"
- 2.01 - 3.00 "Stable"
- > 3.01 "Stable"

Figure Title: Source and runout zones		
Project Name: Coille Beith Wind Farm		
Project No./Filery ID: 1620016742 / REH2024N00315		
Date: June 2025	Figure No.: 8.4.9	Revision: 1.0
Prepared By: OWC-NT	Scale: 1:17,500 @A3	
Client: **Statkraft**		

Statkraft RAMBOLL

1620016742-RAM-MA-IA-0000X_FigxA3_PLHRA_L09_Source_Runout_Zones.pagx

Coordinate System: British National Grid. Projection: Transverse Mercator. Datum: OSGB 1936.



Legend

- Study Area
- Proposed Turbine
- Existing Access Track - No Upgrade
- Existing Access Track To Be Upgraded As Required
- Proposed Access Track
- Access Track Widening
- Floating Track
- Proposed Turning Head
- Proposed Substation
- Proposed Hardstanding
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Earthworks
- Source zones

Calculated risk

- Negligible (depth and/or forestry limited)
- Low (depth and/or forestry limited)
- Low (unconstrained)

Figure Title	Calculated Risk
Project Name	Coille Beith Wind Farm
Project No./Filery ID	1620016742 / REH2024N00315
Date	June 2025
Figure No.	8.4.10
Revision	1.0
Prepared By	OWC-NT
Scale	1:17,500 @A3
Client	Statkraft

Statkraft RAMBOLL

1620016742-RAM-MA-IA-0000X_FigxA3_PLHRA_L10_CalculatedRisk.pagx

Coordinate System: British National Grid. Projection: Transverse Mercator. Datum: OSGB 1936.